

REVISION OF THE PERCOPHID GENUS *BEMBROPS* (ACTINOPTERYGII: PERCIFORMES)

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ABSTRACT

The validity of the 18 nominal species of *Bembrops* are examined in a revision of this marine fish genus. Over 700 specimens were examined, and principal components analysis was performed on 259 specimens using 26 traditional morphometric, 21 truss, and 15 meristic characters and two attributes. Most of the meristic characters and attributes (including pigmentation on membranes between the spines of the first dorsal fin) are useful in identifying the species; however, some truss characters and a few morphometric characters are helpful. Thirteen species of a monophyletic *Bembrops* are recognized as valid, one of which, *B. cadenati*, is described as new, and five nominal species are regarded as junior synonyms as follows: *B. adenensis* of *B. caudimacula*, *B. aethalea* of *B. platyrhynchus*, *B. filodorsalia* of *B. filifera*, *B. indica* of *B. filifera*, and *B. philippinus* of *B. platyrhynchus*. A synonymy, diagnosis, and description are given for each species; in addition, remarks on their taxonomy and interrelationships, distribution, biology, and etymology are also provided. A key to the 13 valid species is presented.

Species of the percophid teleost fish genus *Bembrops* (Perciformes: Trachinoidei) are found on the continental shelf and slope areas and off some oceanic islands of tropical and warm temperate regions of the Indo-West Pacific and Atlantic between depths of approximately 50 and 700 m. The genus was erected by Steindachner (1876) to describe a new species, *B. caudimacula*, from near Nagasaki, Japan. Since then 17 more species of the genus have been described. Following Steindachner's placement of *Bembrops* in the trachinoid family Trachinidae, the genus has been classified in various families as follows: Merluciidae (Goode, 1880), Chaenichthyidae (Goode and Bean, 1896), Nototheniidae (Cadenat, 1937), Leptoscopidae (Boulenger, 1901; Jordan and Snyder, 1902; Taki, 1953), Pteropsaridae (Gilbert, 1905; Jordan and Seale, 1906; Jordan, 1923), and Bembropsidae (currently considered to be a subfamily of Percophidae) (Regan, 1913; Fowler, 1938a, 1939; Norman, 1939; Berg, 1940; Okamura and Kishida, 1963; Smith, 1965; Lindberg and Krasnyukova, 1969). Ginsburg (1955) made a detailed review of Regan's and Jordan's classifications of the genera and included *Bembrops* in the family Percophidae. Poll (1959), Schultz (1960), and Greenwood et al. (1966) followed Ginsburg. McKay (1971) divided the family Percophidae into four unnamed groups and included *Bembrops* and *Chrionema* Gilbert (= *Chriomystax* Ginsburg) in one of the groups. Nelson (1976) divided the family into three subfamilies, currently recognized as the Percophinae, Bembropinae, and Hemerocoetinae. The subfamily Bembropinae includes two genera, *Bembrops* and *Chrionema*. Steyskal (1980), dealing with the grammar of family-group names, corrected the spelling of the family name to Percophidae (first used by Ribeiro, 1915) from Percophididae. This was followed by Nelson (1984, 1994) and Eschmeyer (1990).

Few comprehensive studies of any percophid genus exist (Iwamoto and Staiger, 1976; Nelson, 1979, 1982; Okamura and Kishida, 1963), and no detailed osteological studies are available. The primary objective of this paper is to determine the validity of the presently recognized 18 nominal species. It is part of a study (Das, 1993) initiated to provide information on the phylogenetic interrelationships of the species of *Bembrops* based on comparative anatomy. The endings of several

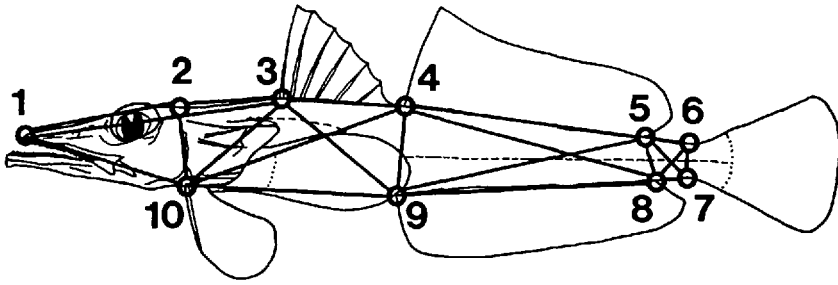


Figure 1. Truss network for species of *Bembrops*. Locations of 10 landmarks are illustrated as open circles and morphometric distance measures between circles as solid lines. See text and Appendix 1 for details.

specific names of the species of *Bembrops* may be incorrect. Article 30 of the current code of the International Commission of Zoological Nomenclature requires that *Bembrops* be treated as masculine; thus, endings of any feminine specific names if treated as adjectives should be changed to masculine. In the interest of nomenclatural stability we have not made changes because of uncertainty in the grammar of most of these names (perhaps only *caudimacula* should be changed, in this case to *caudimaculus*).

METHODS AND MATERIALS

Some 26 traditional morphometric measurements, 15 meristic characters, and two subjectively quantified attributes were recorded for 259 specimens. Many of these characters have been used by other workers (Ginsburg, 1955; Nelson, 1978). Measurements and counts follow Hubbs and Lagler (1964). Log-transformed measurements were used in the morphometric analyses rather than ratios following the advice of Atchley et al. (1976), Atchley and Anderson (1978), and Humphries et al. (1981). Proportional measurements of selected morphometric characters, based on standard length, are given in the species descriptions, enabling the results to be compared with other studies on *Bembrops* and related groups (Nelson, 1978; Iwamoto and Staiger, 1976). Appendix 1 gives details of all 43 characters. From the original 43 characters, five meristic characters (DRF1S, PELFS, PELFR, CAUDFR, and BRACSTGL) were discarded before in-depth analysis because they did not show any variation between species.

A box-truss scheme was also used because of criticisms in using morphometric characters which tend to concentrate on measurements along the horizontal axis of the body (Humphries et al., 1981; Strauss and Bookstein, 1982; Bookstein et al., 1985). Such truss character sets using landmark points are less biased in their directional description of the body-form because they produce a more systematic geometric characterization of shape (Strauss and Bookstein, 1982). The following landmarks were analyzed: 1) tip of snout; 2) occiput; 3) origin of first dorsal fin; 4) origin of second dorsal fin; 5) insertion of second dorsal fin; 6) dorsal tip of hypural plate; 7) ventral tip of hypural plate; 8) insertion of anal fin; 9) origin of anal fin; 10) insertion of pelvic fin. Some 21 interlandmark distances (Fig. 1, Appendix 1) were measured from these 10 landmark points.

Initially, an analysis was made of specimens of all 18 nominal species. From this, groups of species that were particularly close were subject to more detailed study (as described below). Clusters of similarly appearing individuals were identified in the plots of principal components scores and interpreted to represent separate species. For the detailed analysis, the morphologically similar species were analysed using the following data sets. Data set 1. log-transformed morphometric measurements; Data set 2. truss characters; Data set 3. meristic characters and attributes; Data set 4. log-transformed morphometric measurements, meristic characters, and attributes; Data set 5. truss characters, meristic characters, and attributes.

In establishing the phenotypic distinctiveness of the nominal species, PCA scores were plotted in simple bivariate scatter plots. The most enhanced discrimination among species was obtained by plotting PCI of data set 3 against PCII of data set 2. This result is presented in the species descriptions. PCI was not used in the scatter plots for the data set 2 due to its high positive loading, suggesting that it represents a general size factor.

Species accounts are provided in alphabetical order. Unless otherwise indicated, information on the

female gonad maturity presented in the Biological Notes section was collected by M.K.D. In the Materials Examined section, a standard length measurement associated with a catalog number indicates that counts and measurements were taken from that specimen(s) and the data were used in the principal components analysis. All other listed materials (Other Materials Examined) were used to confirm species identity and to establish locality records (shown on the maps). Records shown on the distribution maps may represent more than one collection. The distribution of each species is also summarized. Institutional abbreviations follow Leviton et al. (1985).

TAXONOMY OF THE GENUS *BEMBROPS*

Family Percophidae

Genus *Bembrops* Steindachner, 1876

Bembrops Steindachner, 1876: 211 (type species, *Bembrops caudimacula* Steindachner, 1876, by monotypy).

Hypsicometes Goode, 1880: 347 (type species, *Hypsicometes gobioides* Goode, 1880, by monotypy).

Bathypercis Alcock, 1894a: 177 (type species, *Bathypercis platyrhynchus* Alcock, 1894a, by monotypy).

Diagnosis.—A percophid with a tentacle at posterior tip of each maxilla; a deep notch at posterior tip of maxilla; a median gap between two arms of palatine in area of its articulation with mesopterygoid; wide proximal end of third branchiostegal ray; eyes relatively large, 7.2–15.4% of SL; L.L. scales 40–69; D. VI, 13–17; P. 17–26; A. 14–18; C. 13.

Description.—Counts of selected meristic characters for the 13 valid species of *Bembrops* are provided in Table 1.

Body oblong. Head flattened, maximum width at opercular area. Lateral profile of snout somewhat convex. Upper jaw extending behind anterior margin of eye. Ascending process of premaxilla moderately long, slightly broader proximally and situated perpendicular on premaxilla. Postmaxillary process of premaxilla well developed, wider at base and with rounded dorsal margin. Fine teeth on premaxilla, dentary, vomer, and palatine. Maxilla toothless, exposed, with well-developed tentacle at posterior tip. Anterolateral process of maxilla directed forward but not protruding from transverse skin fold. Lower jaw protruding forward past upper jaw. Eyes large, situated high on side of head, closer to anterior end of snout than to end of opercular flap; interorbital width very narrow, flat. Opercle with two diverging spines near its dorsal margin. Subopercle with a dorsoposteriorly extending weakly ossified blade directed diagonally toward posterior tip of operculum. One spine on lower arm of subopercle. Two small spinous processes on posterior tip of posttemporal. Pseudobranchs well developed. Ceratohyal without cirri or other internal projections. Branchiostegal rays 7. Two dorsal fins, first with 6 slender spines, second with 13–17 branched, soft rays. Pectoral fin with 17–26 branched, soft rays. Pelvic fin with one spine and 5 soft rays. Anal fin with 14–18 soft rays, with last 4 or 5 branched (last ray of anal fin with two branched elements). Caudal fin with 11 branched rays. Dorsal procurent rays 7–11, and ventral procurent rays 5–9. Scales ctenoid, present on lateral and dorsal surfaces of snout, absent in gular region, present at the base of pectoral and pelvic fins; prominent keel on anterior 4 or 5 lateral-line scales. Lateral line descending gradually or abruptly in the area of pectoral fin to below the mid-line (Fig. 2). Few to numerous dark spots on caudal fin. Some 2–13 circular or oval dark blotches along lateral line.

Maximum length approximately 350 mm. Primarily carnivorous, feeding on other smaller fishes, with some species also feeding on crustaceans (Knapp, 1981).

Table 1. Frequency distributions for nine meristic characters of 13 species of *Bembrops*

Species	Lateral line scales															
	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55
<i>B. anatirostris</i>																
<i>B. cadenati</i>																
<i>B. caudimacula</i>			2	—	1	1	—	6	8	5	5	4	5	3	1	
<i>B. curvatura</i>	1	1	—	—	—	1	3	5	5	1						
<i>B. filifera</i>																
<i>B. gobioides</i>																
<i>B. greyi</i>													2	—	—	1
<i>B. heterurus</i>															1	—
<i>B. macromma</i>															5	5
<i>B. magnisquamis</i>						1	—	1	1	1	1					
<i>B. morelandi</i>																
<i>B. nematopterus</i>					1	1	—	—	1							
<i>B. platyrhynchus</i>								1	—	—	7	8	7	8	7	—
Species	Second dorsal fin rays							Pectoral fin rays								
	13	14	15	16	17	Mean	SD	17	18	19	20	21				
<i>B. anatirostris</i>			4	26		14.9	0.3									
<i>B. cadenati</i>				1		15.0	—									
<i>B. caudimacula</i>	2	37	2			14.0	0.3				1	1	4			
<i>B. curvatura</i>		16	1			14.0	0.2				1	8	6			
<i>B. filifera</i>		5	28	3		14.9	0.5									
<i>B. gobioides</i>				4	17	16.9	0.2									
<i>B. greyi</i>				2	1	16.3	0.6									
<i>B. heterurus</i>		17	2			14.1	0.3	1	—	—	—	—	1			
<i>B. macromma</i>		32	3			14.1	0.3									
<i>B. magnisquamis</i>			4	1		15.2	0.4									1
<i>B. morelandi</i>	1	1				13.5	—									
<i>B. nematopterus</i>	1	2				13.6	0.6									1
<i>B. platyrhynchus</i>	2	37	3	1		14.1	0.4									
Species	Rows of scales between lateral line and origin of first dorsal fin							Rows of scales between lateral line and origin of anal fin								
	2	3	4	5	6	Mean	SD	3	4							
<i>B. anatirostris</i>			1	24	5	4.1	0.4									
<i>B. cadenati</i>				1		4.0	—									
<i>B. caudimacula</i>	1	39	1			3.0	0.2									
<i>B. curvatura</i>	13	4				2.2	0.4			3		14				
<i>B. filifera</i>		3	31	2		4.0	0.4									
<i>B. gobioides</i>			2	9	10	5.4	0.6									
<i>B. greyi</i>	1	2				2.7	0.6									
<i>B. heterurus</i>			1	18		4.9	0.2									
<i>B. macromma</i>		24	10	1		3.3	0.5									
<i>B. magnisquamis</i>	1	1	3			3.4	0.9						4			
<i>B. morelandi</i>		2				3.0	—									
<i>B. nematopterus</i>	3					2.0	—									
<i>B. platyrhynchus</i>	13	27	2			2.7	0.5							2		
Species	Gill rakers on upper lobe of branchial arch						Gill rakers on lower lobe of branchial arch									
	3	4	5	6	Mean	SD	10	11	12	13	14	15	16	Mean	SD	
<i>B. anatirostris</i>		2	10	18	5.5	0.6			2	14	13	1		13.4	0.7	
<i>B. cadenati</i>				1	6.0	—					1			14.0	—	
<i>B. caudimacula</i>	3	37	1		3.9	0.3		2	5	16	8	5	5	13.7	1.3	
<i>B. curvatura</i>	12	4	1		3.3	0.6	3	6	5	3				11.5	1.0	
<i>B. filifera</i>	2	20	13	1	4.4	0.6		2	5	12	14	3		13.3	1.0	
<i>B. gobioides</i>			5	16	5.8	0.4			4	10	7			13.0	0.7	
<i>B. greyi</i>			3		5.0	—		1	2					11.7	0.6	
<i>B. heterurus</i>		2	12	5	5.1	0.6			1	7	10	1		13.5	0.7	
<i>B. macromma</i>		12	11	12	5.0	0.8			13	18	3	1		12.8	0.7	
<i>B. magnisquamis</i>		3	2		4.4	0.5			1	3	1			13.0	0.7	
<i>B. morelandi</i>		2			4.0	—						2		15.0	—	
<i>B. nematopterus</i>			3		5.0	—						1	2	15.6	0.6	
<i>B. platyrhynchus</i>	1	34	7		4.1	0.4		4	13	19	4	2		12.7	0.9	

Table 1. Extended

Lateral line scales																
56	57	58	59	60	61	62	63	64	65	66	67	68	69	Mean	SD	
				2	—	3	8	6	1	5	4	1		64.2	2.0	
						1								62.0	—	
														48.9	2.8	
														46.3	2.4	
				4	3	5	6	7	5	5	—	—	1	63.4	2.1	
				1	—	3	1	7	4	5				64.1	1.8	
														53.0	—	
5	2	4	5	2										57.6	1.6	
—	4	3	3	6	3	3	2	1						58.3	3.0	
														47.8	1.9	
1	—	1												57.0	—	
														45.6	2.1	
4	1													52.3	2.1	
Pectoral fin rays								Anal fin rays								
22	23	24	25	26	Mean	SD		14	15	16	17	18	Mean	SD		
	5	17	7	1	24.1	0.7					7	23	17.8	0.4		
	1				23.0	—						1	18.0	—		
8	16	9	2		22.7	1.2	1	6	30		4		15.9	0.6		
2					20.5	0.8		14	3				15.2	0.4		
2	4	16	14		24.2	0.8			2		33	1	16.9	0.3		
1	2	9	8	1	24.3	0.9					4	17	17.8	0.5		
		1	2		24.7	0.6						3	18.0	—		
3	12	2			22.5	1.5			2	16		1	16.9	0.4		
20	11	4			22.5	0.7					8	27	17.8	0.4		
4					21.8	0.4					5		17.0	—		
			1	1	25.5	—				1	1		16.5	—		
2					21.6	0.6				3			16.0	—		
3	12	13	15		23.9	0.9		5	36		2		15.9	0.4		
Rows of scales between lateral line and origin of anal fin						Rows of scales between lateral line and insertion of anal fin						Mean	SD			
5	6	7	Mean	SD		2	3	4	5	Mean	SD					
7	20	3	5.9	0.6	2	24	4			3.1	0.4					
		1	7.0	—			1			4.0	—					
4	29	8	6.1	0.5		40	1			3.0	0.2					
			3.8	0.4	3	14				2.8	0.4					
1	31	4	6.1	0.4		33	3			3.1	0.3					
13	8		5.3	0.5		21				3.0	—					
3			5.0	—		3				3.0	—					
	11	8	6.4	0.5		12	6		1	3.4	0.6					
11	19	5	5.8	0.7	4	31				2.9	0.3					
1			0.4	—	5					2.0	—					
	1		6.0	—			1			3.0	—					
3			5.0	—			3			3.0	—					
36	5		5.1	0.4		42	1			3.0	0.1					

Remarks.—Alcock (1894b) considered *Bathypercis* a junior synonym of *Bembrops*. Later, Alcock (1899, 1902) noted similarities between *Bembrops* and *Hypsicometes* and synonymized both *Bathypercis* and *Hypsicometes* with *Bembrops*. Jordan and Snyder (1902) supported Alcock's view. Our study, in showing that the type species of these nominal genera are not phenotypically distinct from the other species collectively (nor cladistically distinct in our unpublished data), supports this generic synonymy.

Distribution.—Species of the genus are distributed throughout tropical and warm temperate regions of the Indo-West Pacific and Atlantic between the latitudes of approximately 40°N and 40°S. They are found on the continental shelf and slope

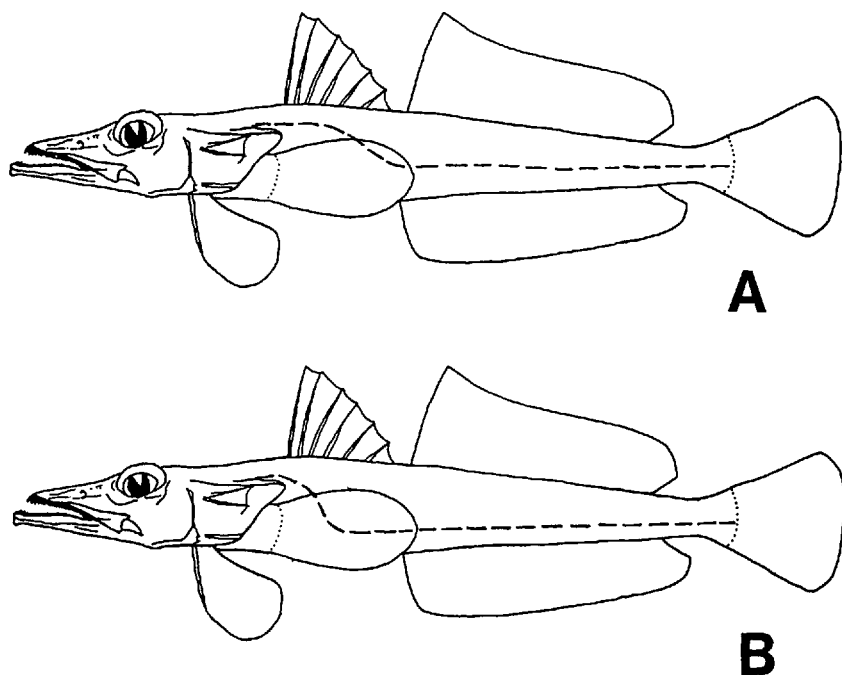


Figure 2. Variation in the slope of the lateral line in *Bembrops*. A. Lateral line descending gradually (variously represented by most species). B. Lateral line descending abruptly (represented by *B. curvatura* and *B. gobioides*).

areas and off some oceanic islands between depths of approximately 50 and 700 m.

KEY TO THE SPECIES OF *BEMBROPS*

- | | |
|--|------------------------|
| 1a. Lateral line descending gradually (Fig. 2A) | 2 |
| 1b. Lateral line descending abruptly (Fig. 2B) | 12 |
| 2a. Scales present in area in front of eye | 3 |
| 2b. Scales absent in area in front of eye | <i>B. macromma</i> |
| 3a. Lateral-line scales 42–60 (rarely 60) | 4 |
| 3b. Lateral-line scales 60–69 (rarely less than 60) | 10 |
| 4a. Dark pigmentation on membranes between spines of 1st dorsal fin restricted to anterior 4 spines | 5 |
| 4b. Dark gray to black pigmentation on membranes between all 6 spines of 1st dorsal fin | 9 |
| 5a. Maxillary tentacle long and slender, 3.5–4.0× into length of maxilla | 6 |
| 5b. Maxillary tentacle short and somewhat stumpy, 5.5–6.0× into length of maxilla | <i>B. heterurus</i> |
| 6a. Membrane between anterior 2 spines of 1st dorsal fin almost black | 7 |
| 6b. Membrane between anterior 3 or 4 spines of 1st dorsal fin dark brown or gray | 8 |
| 7a. Almost-black pigmentation on membrane between anterior 2 spines of 1st dorsal fin limited to distal edge; lateral-line scales 44–48; pectoral fin rays 21 or 22; anal fin rays 16 | <i>B. nematopterus</i> |
| 7b. Jet black pigmentation on entire membrane between anterior 2 spines of 1st dorsal fin; lateral-line scales 56–58; pectoral fin rays 25 or 26; anal fin rays 16 or 17 | <i>B. morelandi</i> |
| 18a. Membrane between anterior 3 spines of 1st dorsal fin with darker pigmentation; lateral-line scales 42–54; 2nd dorsal fin rays 13–15 (rarely 15); pectoral fin rays 19–25; anal fin rays 14–17 | <i>B. caudimacula</i> |

¹ All individuals of these two species cannot be separated in this key. Morphometric and osteological characters must be used to separate all individuals.

- ¹8b. Membrane between anterior 4 spines of 1st dorsal fin with dark brown base; lateral-line scales 45–50; 2nd dorsal fin rays 15 or 16; pectoral fin rays 21 or 22; anal fin rays 17. *B. magnisquamis*
- 9a. Dark gray to black pigmentation on 1st dorsal fin confined to distal edge; lateral-line scales 47–57; 2nd dorsal fin rays 13–16; pectoral fin rays 22–25; anal fin rays 15–17 *B. platyrhynchus*
- 9b. Dark gray to black pigmentation on 1st dorsal fin present on most or entire surface; 2nd dorsal fin rays 15–17; pectoral fin rays 25; anal fin rays 18 *B. greyi*
- 10a. Caudal spot present 11
- 10b. Caudal spot absent *B. cadenati*
- ²11a. Caudal spot present only on dorsal edge; 1st dorsal spine elongate in adults of both sexes *B. filifera*
- ²11b. Caudal spot present well below dorsal edge; 2nd or 3rd dorsal spine elongate in adult males *B. anatirostris*
- 12a. Lateral-line scales 40–49; 2nd dorsal fin rays 14 or 15; pectoral fin rays 19–22; anal fin rays 15 or 16 *B. curvatura*
- 12b. Lateral-line scales 60–66; 2nd dorsal fin rays 16 or 17; pectoral fin rays 22–26; anal fin rays 17 or 18 *B. gobioides*

SPECIES ACCOUNTS

Bembrops anatirostris Ginsburg, 1955

Bembrops anatirostris Ginsburg, 1955: 635, fig. 120 (Gulf of Mexico, east of Mississippi Delta); Grey, 1959: 336–339 (key, description, color, fig. 54); Miller and Jorgensen, 1973: 309 (meristics); Nelson, 1978: 240 (meristics, distribution); Uyeno et al., 1983: 40, 405 (listed, fig., diagnosis, description); Richards, 1990: 54–55 (larvae, listed, figs. 13–15).

Diagnosis.—Gradually descending lateral line with relatively high number of lateral-line scales (60–68); elongate second or third spine of first dorsal fin in large males. L.L. scales 60–68; D. VI, 14–15; P. 23–26; A. 17–18. A member of the *anatirostris* species group (with *B. gobioides*, *B. cadenati*, and *B. heterurus*) defined by the extended anterior end of the third hypobranchial. Differs from *B. filifera* in having more anal fin rays (18 in 77% of *B. anatirostris* specimens vs. 17 in 96% of *B. filifera* specimens). Distinguished from *B. gobioides* in slope of lateral line, and in number of second dorsal fin rays (15 in 87% of *B. anatirostris* specimens vs. 17 in 93% of *B. gobioides* specimens).

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 2.

Snout moderately long, 1.5–1.9× eye diameter. Scales on lateral and dorsal sides of snout. Upper jaw extending behind anterior margin of eye but not reaching its mid-line. Maxillary tentacle long and slender. Lateral line separated from origin of first dorsal fin by 3–5 rows of scales, from origin of anal fin by 5–7, and from insertion of anal fin by 2–4. Larger males (SL > 170 mm) with elongated second or third spine of first dorsal fin. Predorsal length for first dorsal fin almost equal to head length. Pectoral fin moderately rounded. Caudal fin emarginate with upper lobe slightly larger than lower lobe in some specimens, two lobes of equal length in others. Gill rakers 4–6 on upper limb and 12–15 on lower limb of branchial arch.

Color in Alcohol.—Yellowish brown dorsally, lighter ventrally. Scales with darker edge. Series of 5–10 dark spots along lateral line, relatively indistinct in larger specimens. Membranes between first three or four spines of first dorsal fin darker;

² All individuals of these two species cannot be separated in this key. Osteological characters must be used to separate all individuals.

Table 2. Proportional measurements of selected morphometric characters for four species of *Bembrops* (expressed as percentage of standard length)

Measurements	<i>B. anatrostris</i> (N = 30) (SL = 113.0–262.0 mm)			<i>B. cadenati</i> (N = 1) (SL = 164.3 mm) Holotype			<i>B. caudimaculata</i> (N = 41) (SL = 76.6–177.0 mm)			<i>B. curvatura</i> (N = 21) (SL = 91.9–153.2 mm)		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
Head length	35.0–41.9	38.8	1.5	37.3	38.0–48.5	42.6	2.5	36.2–42.9	38.9	1.7		
Head width	12.3–16.0	14.1	0.9	15.3	12.8–21.8	15.8	1.9	13.2–16.1	14.8	1.2		
Head height	9.5–12.6	10.8	0.8	10.9	9.2–15.4	11.3	1.4	9.7–12.0	10.5	0.7		
Snout length	12.3–15.9	13.7	1.0	12.2	12.3–19.5	13.6	1.4	11.9–13.7	12.8	0.7		
Postorbital length	15.1–19.5	17.2	0.8	16.7	15.7–28.5	20.2	2.6	16.1–20.0	18.1	0.9		
Body depth	11.0–15.8	13.0	1.3	12.2	10.3–19.9	13.1	1.8	10.8–13.8	12.2	0.9		
Predorsal length (1st)	37.8–42.1	40.0	1.2	37.9	37.9–44.1	41.2	1.7	35.7–39.7	37.4	1.5		
Predorsal length (2nd)	52.3–58.2	55.7	1.6	53.3	53.8–59.8	57.3	1.8	53.1–56.0	54.7	1.2		
Postdorsal length (1st)	50.0–55.2	52.3	1.4	54.5	44.6–54.8	50.8	2.1	50.3–55.7	53.4	1.8		
Postdorsal length (2nd)	10.1–14.6	12.4	1.0	13.3	10.4–14.7	12.5	1.4	11.1–14.2	12.9	0.8		
Interpectoral distance	8.4–15.7	12.5	1.6	12.7	9.1–15.6	12.5	1.8	7.7–14.9	12.0	1.7		
Interpelvic distance	5.6–8.0	6.7	0.6	6.6	5.3–15.1	7.3	1.8	5.8–7.2	6.4	0.4		
Length of caudal peduncle	8.1–14.0	10.2	1.2	11.0	8.7–15.3	10.7	1.8	9.4–12.4	10.8	0.9		
Depth of caudal peduncle	3.9–5.1	4.7	0.3	5.4	4.5–7.0	5.8	0.8	5.2–6.9	5.8	0.4		

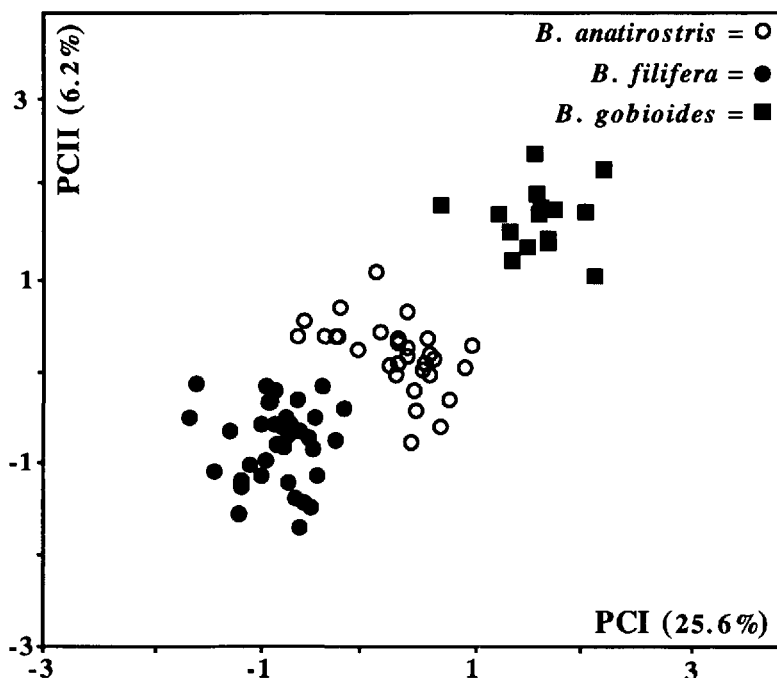


Figure 3. PCA of *B. anatirostris*, *B. filifera*, and *B. gobioides*. The X axis is the PCI of data set 3 and the Y axis is the PCII of data set 2. Percent variance of total variation for each factor is given in parentheses.

posterior edge of elongated spine also darker. Spots on caudal fin indistinct. Peritoneum black.

Remarks.—Ginsburg (1955) noted the close resemblance of *B. anatirostris* to *B. gobioides*, and Grey (1959) mentioned its close similarity to *B. filifera*. PCA scatter plots suggest that *B. anatirostris* is morphologically more similar to *B. filifera* than to *B. gobioides*. Both the PCI of the data set 3 and the PCII of the data set 2 are important in species discrimination (Fig. 3). The distance between the ventral tip of the hypural plate and the insertion of the anal fin (Truss 8), and the number of anal fin rays contributed most in these two analyses.

Distribution.—Western Atlantic from the Gulf of Mexico, Caribbean Sea off Puerto Rico, Surinam, and French Guiana (Fig. 4).

Biological Notes.—This is a relatively large member of the genus with a maximum length of 262 mm SL and known from depths of 100 to over 350 m. Female specimens collected in January, February, April, and May have ripe eggs. Richards (1990) illustrates several larval stages of this species. Caudal and pectoral fins appear at the 2.0 mm SL stage. All fins and the maxillary tentacles are prominent at the 9.4 mm SL stage. Pigmentation appears first at the base of the pectoral fin and on side in front of caudal peduncle.

Etymology.—The specific name is derived from the Latin *anatinus*, meaning duck's, and *rostrum*, meaning beak or snout, and refers to the flattened duck-bill like snout.

Materials Examined.—(30 specimens, 113.0–262.0 mm in SL). USNM 155470, 1:229.7 mm SL (ho-

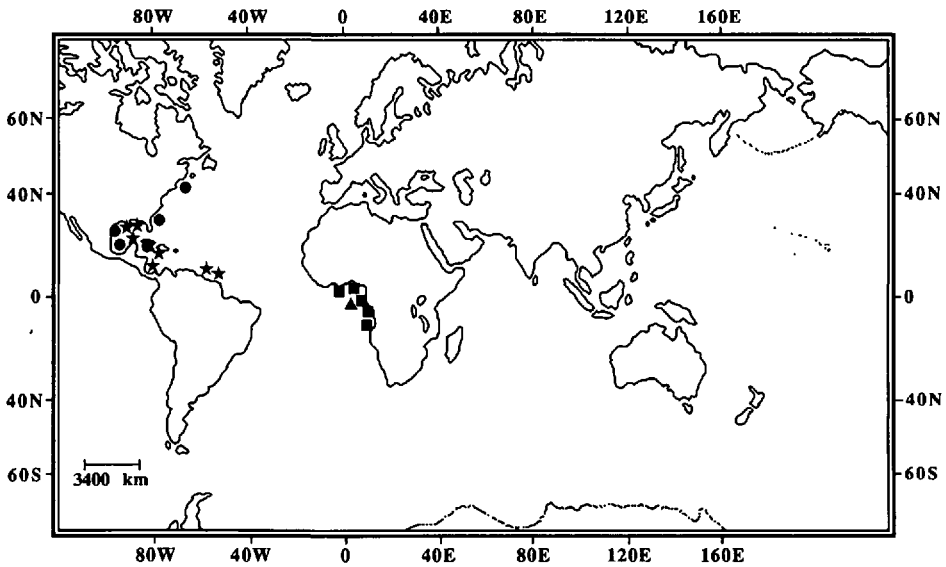


Figure 4. Geographic distribution of *B. anatrostris* (★), *B. cadenati* (▲), *B. gobioides* (●), and *B. heterurus* (■) based on data collected from original species descriptions, other literature sources, and museum collections.

holotype), Gulf of Mexico, east of Mississippi Delta (29°02'N, 88°40'W); USNM 157734, 1: 146.0 mm SL (paratype), Florida off Tampa (28°10'N, 85°00'W); USNM 157735, 4: 198.0–262.0 mm SL (paratypes), off Cape San Blas, Florida (28°41'N, 86°03'W); USNM 157736, 5: 114.7–219.0 mm SL (paratypes), off Pensacola, Florida (29°20'N, 87°42'W); USNM 157737, 5: 190.5–251.0 mm SL (paratypes), Gulf of Mexico, Florida; USNM 157740, 1: 141.7 mm SL (paratype), Florida off Pensacola (30°03'N, 86°56'W); UF 20747, 13: 113.0–176.4 mm SL, Gulf of Mexico, off Florida (29°16'N, 86°05'W).

Other Materials Examined.—USNM 44609, 1 (paratype), Gulf of Mexico, Florida (28°36'N, 85°33'W); USNM 45976, 1 (paratype), Gulf of Mexico, Louisiana (29°14'N, 88°09'W); NSMT P44756, 7, Caribbean Sea (07°32'N, 54°06'W); USNM 231943, 2, West Indies (15°38'N, 61°15'W); USNM 304913, 5, Caribbean, Nicaragua (12°26'N, 82°24'W); USNM 304914, 3, Gulf of Mexico, Louisiana (27°54'N, 90°04'W); USNM 304915, 6, Caribbean, Jamaica (17°53'N, 77°56'W); USNM 304916, 2, Atlantic, Florida (29°03'N, 80°00'W).

Bembrops cadenati new species

Bembrops caudimaculata Cadenat, 1937: 513, fig. 49 (off coast of Guinea, Africa, erroneous spelling of *caudimacula*); Norman, 1939: 69; Poll, 1959: 39 (misidentified as *B. heterurus*); Nelson, 1978: 240 (*B. caudimaculata* of Cadenat, 1937, meristics, short description, distribution).

Diagnosis.—A species of *Bembrops* with 4 scale-rows between lateral line and origin of first dorsal fin, and 4 scale-rows between lateral line and insertion of anal fin. L. L. scales 62; D. VI, 15; P. 23; A. 18. Caudal spot absent. Distinguished from *B. heterurus* in number of anal fin rays (17 in 84% of specimens of *B. heterurus*).

Description.—Nine meristic characters and proportions for 14 morphometric characters for the holotype given in Tables 1 and 2.

Snout relatively short, 1.2× eye diameter. Scales present laterally and dorsally on snout. Upper jaw extending behind anterior margin of eye but not reaching its mid-line. Maxillary tentacle medium-sized, slender. Lateral line descending gradually in posterior third of pectoral fin, separated from origin of first dorsal fin by

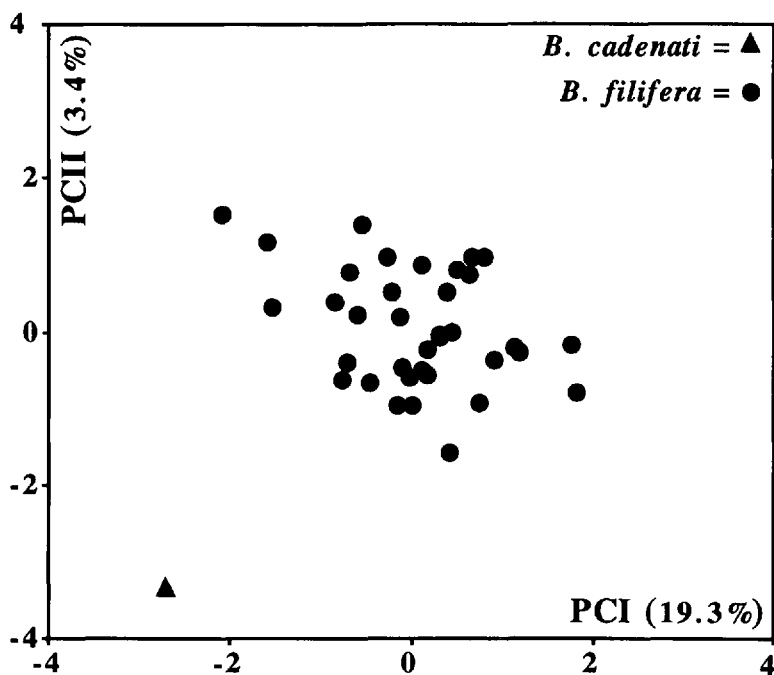


Figure 5. PCA of *B. cadenati* and *B. filifera*. The X axis is the PCI of data set 3 and the Y axis is the PCII of data set 2. Percent variance of total variation for each factor is given in parentheses.

4 rows of scales, from origin of anal fin by 7, and from insertion of anal fin by 4. No evidence of prolongation of any spine of first dorsal fin. Predorsal length for first dorsal fin slightly higher than head length. Pectoral fin relatively pointed. Caudal fin truncate; no prolongation of rays of upper lobe. Gill rakers 6 on upper limb and 14 on lower limb of branchial arch.

Color in Alcohol.—Yellowish brown dorsally, lighter ventrally. Scales with dark brown edge. A series of 7 or 8 very indistinct spots along the lateral line. Membrane between first and second spines of first dorsal fin dark gray. Cadenat (1937) reported presence of a distinct caudal spot, but it is absent in the holotype. Peritoneum dark gray.

Remarks.—The pair-wise PCA separates the holotype of *B. cadenati* from specimens of *B. filifera* (Fig. 5). The distance between the ventral tip of the hypural plate and the insertion of the anal fin (Truss 8), and the number of scales between the first anal fin ray and the lateral line have the highest loadings in the data sets 2 and 3. *B. cadenati* can also be separated from *B. macromma* and *B. heterurus* on PCII of the data set 5, primarily because of the number of scale-rows between the lateral line and the origin of the first dorsal fin, the number of the anal fin rays, and the number of scale-rows between the lateral line and the insertion of the anal fin. The PCI of the data set 3 was also important in the discrimination and has the highest loadings in the number of scales between the first dorsal fin spine and the lateral line (Fig. 6).

Cadenat (1937) erroneously identified a number of specimens from 120–220 m in the Gulf of Guinea with 60–62 lateral line scales as *B. caudimaculata* Steindachner (erroneous spelling of the specific name *caudimacula*) and further

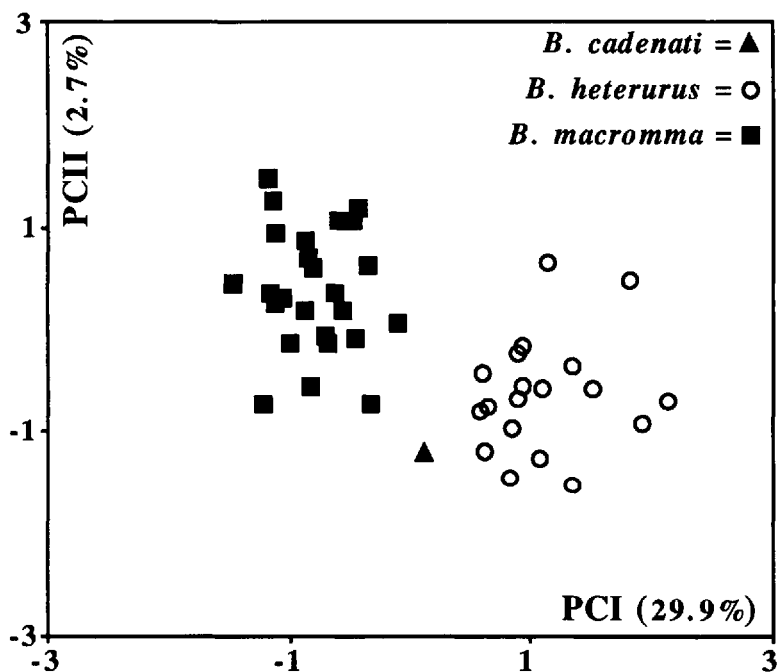


Figure 6. PCA of *B. cadenati*, *B. heterurus*, and *B. macromma*. The X axis is the PCI of data set 3 and the Y axis is the PCII of data set 2. Percent variance of total variation for each factor is given in parentheses.

considered it synonymous with *Hypsicometes gobioides* Goode, *Bathypercis platyrhynchus* Alcock, and *H. heterurus* Ribeiro. Norman (1939) referred to it in a footnote (p. 69). Poll (1959), after examining two specimens received from Cadenat, considered it synonymous with *B. heterurus*. Nelson (1978) recognized it, using Cadenat's spelling of *B. caudimaculata*, as a valid species. We accept its validity as a species in our comparison of the holotype with other species.

Distribution.—Eastern Atlantic in the Gulf of Guinea (Fig. 4). The specimens of Cadenat (1937) were collected from three stations at depths of 120–220 (or 250) m.

Etymology.—The species is named for J. Cadenat in recognition of his work on the marine fishes off western Africa.

Materials Examined.—**Holotype**—MNHN 1938-17, 164.3 mm SL (09°14'N, 15°31'W), 120 m, Stn. 722 of Président Théodore Tissier, off coast of Guinea, Africa, 19 May 1936.

Bembrops caudimacula Steindachner, 1876

Bembrops caudimacula Steindachner, 1876: 212 (Nagasaki, Japan); Alcock, 1894b: 118 (listed, Bay of Bengal, India); Alcock, 1899: 48–50 (synonymy, diagnosis, description, distribution); Alcock, 1902: 120 (listed, fig. 12); Jordan and Snyder, 1902: 470 (description); Jordan et al., 1913: 366 (listed); Kuroda, 1950: 57–60 (description); Matsubara, 1955: 694 (key); Smith, 1965: 178 (meristics, color, fig. 383a); Lindberg and Krasnyukova, 1969: 452–453 (description, distribution, fig. 424); Nelson, 1978: 239 (meristics, short description, distribution); Klauser, 1980: 17–20 (*B. adenensis* of Norman, 1939, description, figs. 1, 2); Munro, 1982: 199 (misidentified as *B. caudimaculata* (sic) Steindachner, 1876, diagnosis); Fourmanoir, 1984: 96 (listed); Kim et al., 1988: 110–111 (description).

Bembrops adenensis Norman, 1939: 69 (Gulf of Aden); Nelson, 1978: 240 (meristics, distribution).

Diagnosis.—Gradually descending lateral line with relatively few lateral-line scales (42–54). L.L. scales 42–54; D. VI, 13–15; P. 19–25; A. 14–17. Distinguished from *B. curvatura* in having a longer snout and a more gradually descending lateral line; and from *B. nematopterus* by its longer head and more scale-rows between lateral line and origin of first dorsal fin (3 or 4 in *B. caudimacula* vs. 2 in *B. nematopterus*). Differentiated from *B. platyrhynchus* in having on average fewer lateral-line scales (47–57 in *B. platyrhynchus*) and more scales between lateral line and origin of anal fin (5–7 in *B. caudimacula* vs. 4–6 in *B. platyrhynchus*).

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 2.

Snout moderately long, 1.4–1.8× eye diameter. Scales present laterally and dorsally on snout including area in front of eye. Upper jaw extending behind anterior margin of eye. Maxillary tentacle long and slender. Lateral line descending gradually adjacent to pectoral fin, separated from origin of first dorsal fin by 3 or 4 rows of scales, from origin of anal fin by 5–7, and from insertion of anal fin by 3 or 4. No prolongation of any dorsal spines. Predorsal length for first dorsal fin almost equal to head length. Pectoral fin rounded. Caudal fin rounded. Gill rakers 3–5 on upper limb of branchial arch and 11–16 on lower limb.

Color in Alcohol.—Yellowish brown dorsally, lighter ventrally. Scales with dark brown edge. A series of 4–12 oval or circular dark brown spots along the lateral line. Membranes between first three spines of first dorsal fin dark gray to black. Caudal fin with dark pigment running along its dorsal edge and a round spot below mid-line. Peritoneum grayish to light yellowish brown, with scattered dark spots in some specimens. Norman (1939) noted “some small scattered yellowish-green markings on head and body.”

Remarks.—The PCA scatter plots (Fig. 7) show that specimens of *B. caudimacula* are distinctly separated from *B. curvatura*, but that *B. caudimacula* is morphologically similar to *B. magnisquamis* and *B. nematopterus* when they are analyzed together with *B. curvatura*. The slope of the lateral line, number of scales between the first anal fin ray and the lateral line, and the color of the peritoneum are important in the data set 3 in discriminating *B. curvatura* from the other three species.

Bembrops caudimacula closely resembles *B. platyrhynchus* on the basis of the characters used in the morphometric analyses. Although their morphometric characters do not show any marked difference, some meristic characters are important in distinguishing most specimens of the two species (Fig. 8). The number of scales between the lateral line and the origin of the anal fin has the highest factor loading among the characters of the data set 3. Pigmentation on the membranes between the spines of the first dorsal fin, which was not used in the PCA, proves to be a distinguishing character for the identity of the two species. A number of osteological characters also show differences (Das, 1993).

Pairwise PCA's performed to compare the morphology between *B. caudimacula* and *B. magnisquamis*, and between *B. caudimacula* and *B. nematopterus* (geographic distributions shown in Fig. 9) show a distinct separation of the *B. caudimacula* cluster from that of *B. magnisquamis* (Fig. 10) and *B. nematopterus* (Fig. 11). The second dorsal fin ray number and number of scales between the last anal fin ray and the lateral line are important in the data set 3 in distinguishing between *B. caudimacula* and *B. magnisquamis*. Gill rakers on upper limb and

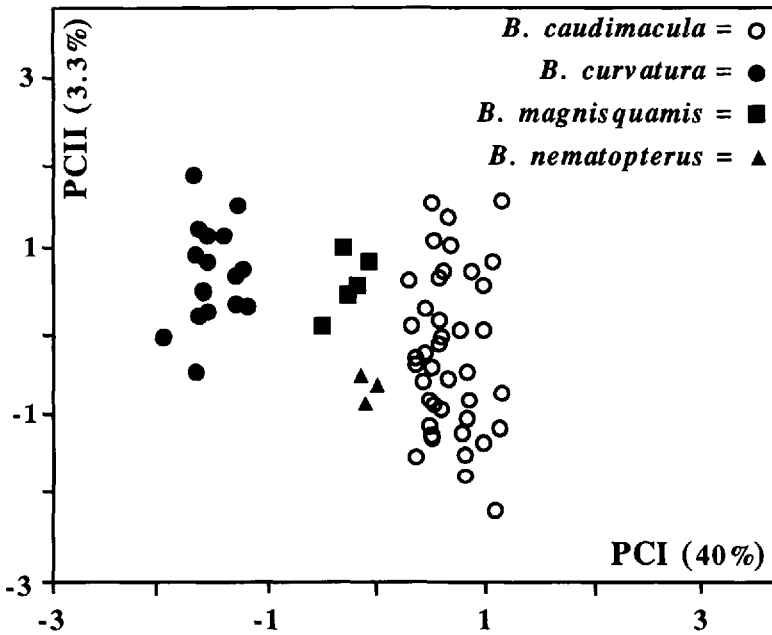


Figure 7. PCA of *B. caudimaculata*, *B. curvatura*, *B. magnisquamis*, and *B. nematopterus*. The X axis is the PCI of data set 3 and the Y axis is the PCII of data set 2. Percent variance of total variation for each factor is given in parentheses.

scales between first dorsal fin spine and lateral line are important in the data set 3 in distinguishing *B. caudimaculata* from *B. nematopterus*.

Steindachner (1876) described *Bembrops caudimaculata* based on a single specimen from Nagasaki, Japan, and erected the genus *Bembrops*. Smith (1965) considered *B. platyrhynchus*, *B. adenensis*, and *B. nematopterus* as synonyms of *B. caudimaculata*. Alcock (1899, 1902) and Kuroda (1950) also listed *B. platyrhynchus* and *B. gobioides* as synonyms of *B. caudimaculata*. At our request, the "recently found" holotype of *B. caudimaculata* was examined by Barbara Herzig, Curator of Fishes at the Naturhistorisches Museum Wien, Austria. This specimen has the lowest number of lateral-line scales for the species. M.K.D. has examined the type specimens of *B. adenensis*, *B. nematopterus*, and *B. platyrhynchus*. Norman (1939) recognized the close resemblance of *B. adenensis* with *B. caudimaculata*, with the exception of the head and snout length and the number of lateral-line scales. *B. caudimaculata* demonstrates considerable variation in the number of lateral-line scales (42–54) over its wide geographic distribution. Based on eight specimens collected from the central Red Sea, Klauswitz (1980) recognized *B. adenensis* as a valid species. Examination (by M.K.D.) of five of these specimens (SMF 15386–88) suggested that their characters fall within the range of *B. caudimaculata*. Hence, we concur with Smith's synonymizing *B. adenensis* with *B. caudimaculata*.

Distribution.—Known from the Indo-West Pacific from Japan and Korea, south to Borneo and northeastern Australia west to the Andaman Sea and Indian Ocean, and in the Gulf of Aden and Red Sea; eastern Atlantic only in the Gulf of Guinea (Fig. 9).

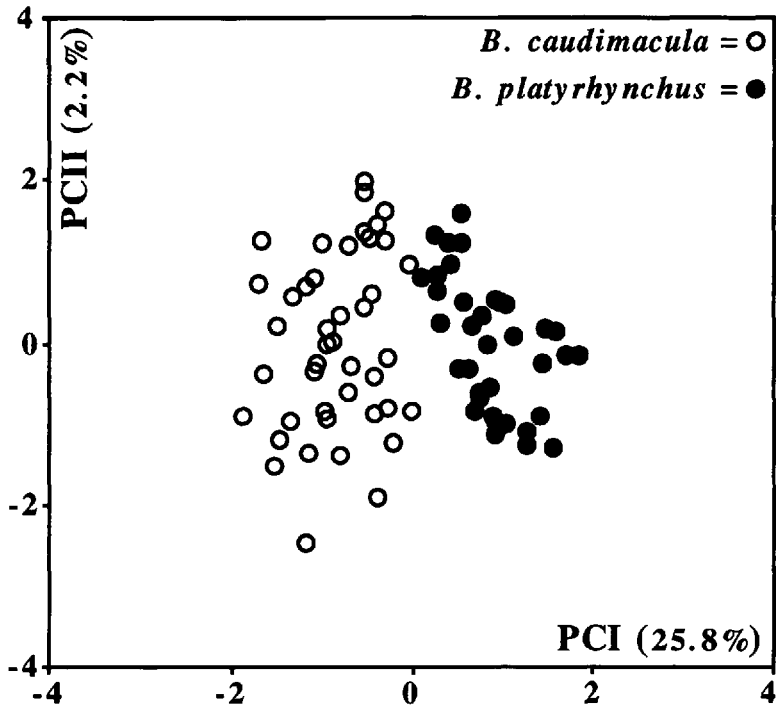


Figure 8. PCA of *B. caudimacula* and *B. platyrhynchus*. The X axis is the PCI of data set 3 and the Y axis is the PCII of data set 2. Percent variance of total variation for each factor is given in parentheses.

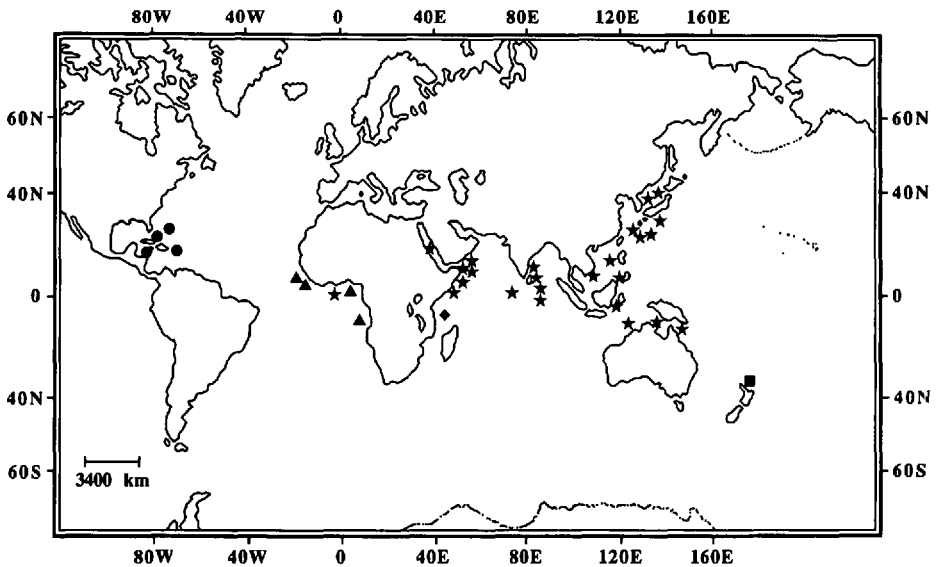


Figure 9. Geographic distribution of *B. caudimacula* (★), *B. greyi* (▲), *B. magnisquamis* (●), *B. morelandi* (■), and *B. nematopterus* (◆) based on data collected from original species descriptions, other literature sources, and museum collections.

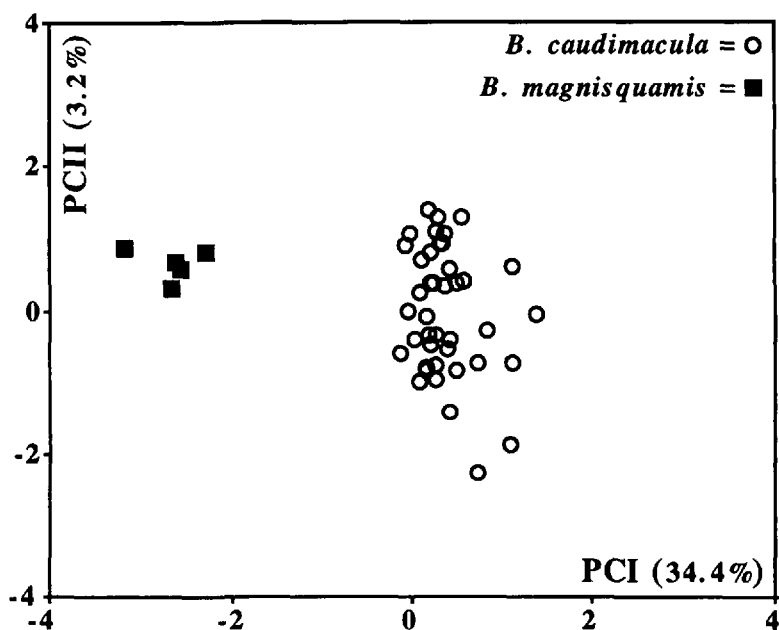


Figure 10. PCA of *B. caudimaculata* and *B. magnisquamis*. The X axis is the PCI of data set 3 and the Y axis is the PCII of data set 2. Percent variance of total variation for each factor is given in parentheses.

Biological Notes.—This is a relatively small to medium-sized member of the genus occurring in relatively deep water at depths of 250 to about 500 m. Female specimens collected in March and May had ripe ova.

Etymology.—The specific name is derived from the Latin *cauda*, meaning tail, and *macula*, meaning spot or stain, and refers to the dark spot on the caudal fin.

Materials Examined.—(41 specimens, 76.6–177.0 mm in SL). NMW 6458, 1: 116.5 mm SL (holotype), Nagasaki, Japan (examined by Dr. Barbara Herzig); BMNH 1939.5.24:1232–71, 5: 112.4–147.3 mm SL (paratypes of *Bembrops adenensis*), Gulf of Aden; BSKU 17632–17636, 5: 142.7–163.8 mm SL, South China Sea (07°26'N, 109°15'E); QM I.20655, 2: 106.7–163.7 mm SL, east of Murray Isles, northern Queensland, Australia (09°53'S, 144°23'E); QM I.22339, 2: 133.4–175.6 mm SL, North West Shelf, Australia (18°21'S, 117°56'E). SMF 15386, 1: 142.2 mm SL, Rotes Meer, southwest Ras Abu Shagara, Sudan (20°54'N, 37°26'E); SMF 15387, 1: 89.9 mm SL, Zentr. Rotes Meer (21°22'N, 39°04'E); SMF 15388, 3: 76.6–96.7 mm SL, Zentr. Rotes Meer (21°22'N, 39°04'E); ZSI F257/1, 1: 115.1 mm SL, Andaman Sea; ZSI F373/1, 1: 177.0 mm SL, Andaman Sea; ZSI F673/1–F676/1, 4: 124.3–168.3 mm SL, Gulf of Manar; ZSI F6300/2, 10: 78.8–164.4 mm SL, off Quillon, Kerala, India; ZSI F7194/2, 5: 134.0–145.0 mm SL, off Quillon, Kerala, India.

Bembrops curvatura Okada and Suzuki, 1952

Bembrops curvatura Okada and Suzuki, 1952: 68 (Owashi, Mie Prefecture, Japan); Matsubara, 1955: 694 (key).

Diagnosis.—Lateral line descending abruptly over pectoral fin. L.L. scales 40–49; D. VI, 14–15; P. 19–22; A. 15–16. Distinguished from *B. caudimaculata*, *B. magnisquamis* and *B. nematopterus* by the presence of very light colored peritoneum and relatively sharp curvature of the lateral line. Distinguished from *B. gobioides* in counts of lateral-line scales (60–66 in *B. gobioides*), second dorsal fin rays (16–17 in *B. gobioides*), and anal fin rays (17–18 in *B. gobioides*).

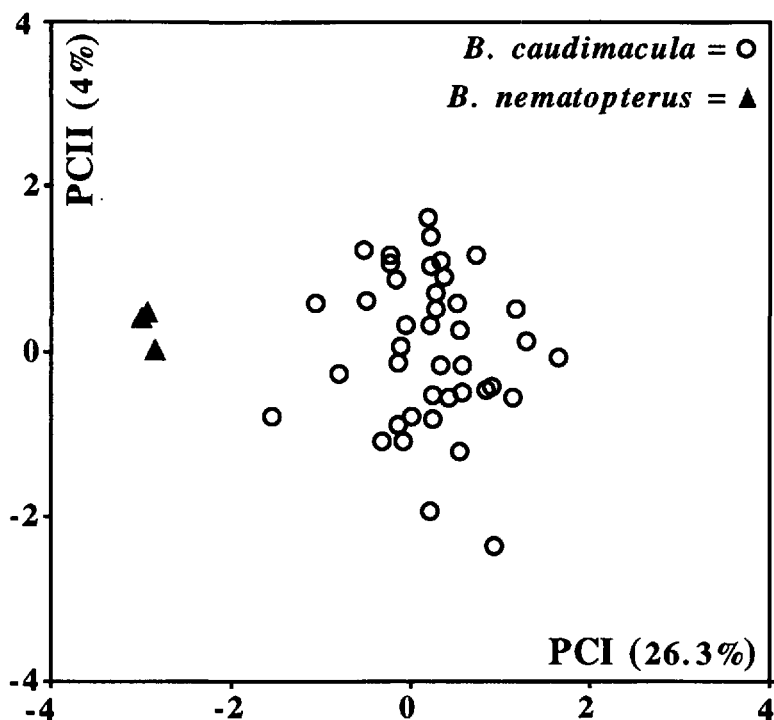


Figure 11. PCA of *B. caudimacula* and *B. nematopterus*. The X axis is the PCI of data set 3 and the Y axis is the PCII of data set 2. Percent variance of total variation for each factor is given in parentheses.

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 2.

Snout relatively short, $1.1\text{--}1.6\times$ eye diameter. Scales on lateral and dorsal sides of snout. Upper jaw extending beyond anterior margin of eye but not reaching mid-line. Maxillary tentacle short and slender. Eyes smaller than in other species. Lateral line descending rather abruptly after a gradual upward slope for two scale-rows from origin; separated from origin of first dorsal fin by 2 or 3 rows of scales, from origin of anal fin by 3 or 4, and from insertion of anal fin by 2 or 3. No evidence of elongation of any spine of first dorsal fin. Predorsal length for first dorsal fin slightly shorter than head length. Pectoral fin relatively pointed. Caudal fin truncate, forming almost a straight line at posterior edge. Gill rakers 3–5 on upper limb of branchial arch and 10–13 on lower limb.

Color in Alcohol.—Yellowish brown dorsally, posterior part of head between eyes darkest; light brown ventrally. Scales between dorsal fins and lateral line with dark brown edge. Series of 4–7 circular or oval dark brown spots below lateral line. Membranes between first two or three spines of first dorsal fin dark gray or black. Caudal fin with a dark (almost black in freshly preserved specimens) blotch near dorsal margin. Peritoneum light yellowish brown with a few spots in some specimens.

Remarks.—*B. curvatura* more closely resembles *B. caudimacula*, *B. magnisquamis*, and *B. nematopterus* than the other species of *Bembrops* in morphology; the specimens of *B. curvatura* are distinctly separated from *B. caudimacula*, *B. mag-*

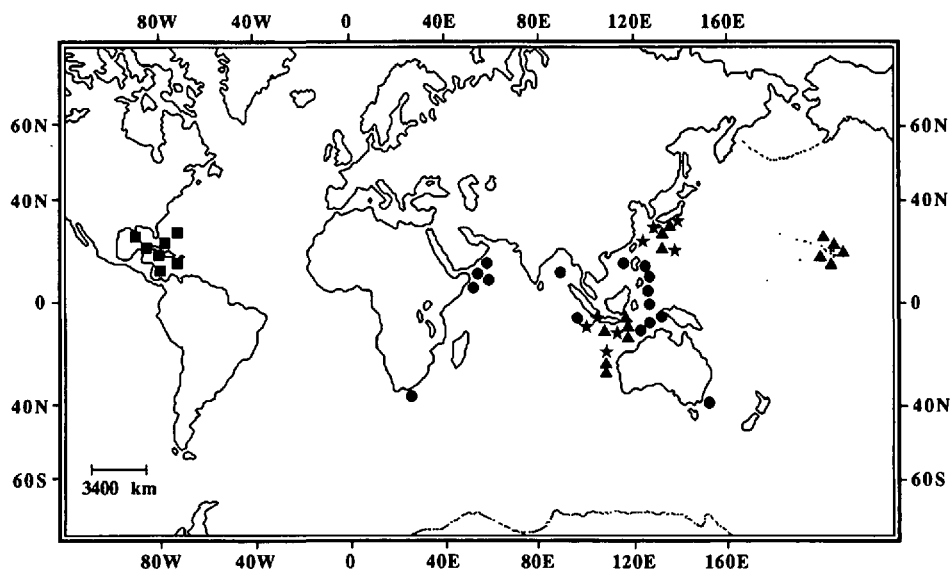


Figure 12. Geographic distribution of *B. curvatura* (★), *B. filifera* (▲), *B. macromma* (■), and *B. platyrhynchus* (●) based on data collected from original species descriptions, other literature sources, and museum collections.

nisquamis, and *B. nematopterus* in a PCA analysis (Fig. 7). See description of *B. caudimacula* for further details.

Distribution.—Known from eastern Indian and western Pacific, from off Japan and surrounding areas, Indonesia, and northwestern Australia (Fig. 12).

Biological Notes.—This is a relatively small species of *Bembrops*. All specimens for which depth information is available have been captured in the 100–280 m range. One female with mature ova was collected in April off the coast of Japan.

Etymology.—The specific name comes from the Latin word *curvatura*, meaning curvature, and refers to the sharply curved lateral line.

Materials Examined.—(21 specimens, 91.9–153.2 mm in SL). FRLM 9768, 1: 133.3 mm SL (holotype), Owashi, Mie Prefecture, Japan; UAMZ 7536, 7: 137.8–153.2 mm SL, Tosa Bay, Japan; FRLM 9779–9786, 8: 91.9–135.6 mm SL, off Owashi, Pacific coast of Mie Prefecture, Japan. NTM S.10740–004, 1: 92.8 mm SL, southern Lombok, Indonesia; NTM S.10751–008, 1: 105.7 mm SL, Saleh Bay, Sumbawa, Indonesia; USNM 59647, 3: 91.2–104.8 mm SL, Kagoshima, Japan.

Bembrops filifera Gilbert, 1905

Bembrops filifera Gilbert, 1905: 643 (off northeast coast of Maui, Hawaii); Jordan and Seale, 1906: 414 (listed); Fowler, 1928: 423 (listed); Fowler, 1938b: 299 (listed); Nelson, 1978: 239 (meristics, distribution); Tinker, 1978: 348–349 (fig., short description); Fourmanoir, 1984: 96 (listed).

Bembrops filodorsalis Okada and Suzuki, 1952: 70 (Owashi, Mie Prefecture, Japan); Matsubara, 1955: 694 (key).

Bembrops indica McKay, 1971: 43 (Indian Ocean, off northern coast of Western Australia, Australia); Nelson, 1978: 240 (meristics, distribution).

Bembrops filodorsalis Okamura, Amaoka, and Mitani, 1982: 386.

Diagnosis.—Gradually descending lateral line and relatively large number of scales. L.L. scales 60–69; D. VI, 14–16; P. 22–25; A. 16–18. Differs from *B. anatirostris* in having elongated first (instead of second or third) spine of first

dorsal fin and fewer anal fin rays. Distinguished from *B. gobioides* in number of lateral-line scales and second dorsal fin rays.

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 3.

Snout long, $1.0\text{--}2.2\times$ eye diameter, with scales on dorsal and lateral sides. Upper jaw extending behind anterior margin of eye but not reaching its mid-line. Maxillary tentacle long and slender. Lateral line descending gradually in area of pectoral fin with 60–69 (only one specimen has 69 scales, others range from 60–66) scales, separated from origin of first dorsal fin by 3–5 rows of scales, from origin of anal fin by 5–7, and from insertion of anal fin by 3 or 4. Many adult specimens of both sexes with elongated first spine of first dorsal fin. Pectoral fin somewhat rounded with middle rays longest. Caudal fin truncate. Gill rakers 3–6 on upper limb and 11–15 on lower limb of branchial arch.

Color in Alcohol.—Yellowish brown to light yellowish dorsally, lighter ventrally. Tinker (1978) gave the body color as olive brown. Scales with darker edge. A series of 9–13 dusky spots along lateral line. Membranes between first three spines of first dorsal fin dark gray. Spot on dorsal edge of caudal fin distinct in some, inconspicuous in others. Peritoneum black to dark grayish in color.

Remarks.—*B. filifera* was reported to be morphologically similar to *B. anatirostris* by Ginsburg (1955) and to *B. gobioides* by Grey (1959). PCA showed that *B. filifera* is more similar to *B. anatirostris* (Fig. 3) than it is to *B. gobioides*. See account of *B. anatirostris* for more comparative information.

Gilbert (1905) based his description of *B. filifera* on a 223 mm (total length) male from the northeastern coast of Maui, Hawaiian Islands taken at a depth between 326 and 370 m. He also reported another immature specimen (53 mm) from the same locality.

Okada and Suzuki (1952) described *B. filodorsalia* from a female specimen collected from Owashi Fish Market, Mie Prefecture, Japan. Okada and Suzuki (1952) compared their holotype with descriptions of *B. caudimacula*, *B. gobioides*, and *B. platyrhynchus* to reach the decision that they had an undescribed species. However, they were probably unaware of the existence of *B. filifera*. The holotype of *B. filodorsalia* is presumed lost (S. Kimura, Mie University, pers. comm.). We consider this species a junior synonym of *B. filifera* based on the study of the original description and examination of three specimens collected at or near type locality. Okamura, Amaoka, and Mitani (1982), in their book on fishes of the Kyushu-Palau Ridge and Tosa Bay, erroneously spelled the name *B. filodorsalis*.

Bembrops indica was described by McKay (1971) from a collection of fishes trawled off the northern coast of Western Australia. The holotype and four paratypes were collected at a depth of 350–370 m and two other paratypes from 62 m. McKay distinguished these specimens from *B. filifera* and designated them as a new species based on the following differences: anal fin rays 17 instead of 18, snout shorter, and coloration different. M.K.D. has examined the holotype and one paratype and, in our opinion, separate species status for these specimens is unwarranted because their characters fall well within the range for *B. filifera*.

Distribution.—Known from eastern Indian Ocean and western Pacific Ocean from the coasts of Japan, Indonesia, and Western Australia and from off the Hawaiian islands (Fig. 12).

Biological Notes.—This relatively large species of *Bembrops* occurs at a wide range of depths (from 62 to about 375 m) but mostly over 300 m. Female specimens collected during February and March off the coast of Japan and during November from Hawaiian Islands appear to have ripe eggs.

Etymology.—The species name is attributed to the filamentous nature of the elongated first spine of the first dorsal fin.

Materials Examined.—(35 specimens, 88.6–219.0 mm in SL). USNM 051613, 1: 219.0 mm SL (holotype), northeastern coast of Maui, Hawaii; AMS I.21804–014, 1: 165.0 mm SL, North West Shelf, west of Darwin, Timor Sea, Australia; BSKU 12373, 1: 189.5 mm SL, Tosa Bay, Japan; BSKU 35489, 1: 193.5 mm SL, Tosa Bay, Japan; BSKU 35551–35553, 3: 180.0–197.0 mm SL, Tosa Bay, Japan; UAMZ 7534, 4: 162.2–206.5 mm SL, northwestern Maui, Hawaii (21°04'N, 156°31'W); BPBM 24287, 20: 88.6–198.2 mm SL, northwestern Maui, Hawaii (21°04'N, 156°32'W); FRLM 9788, 1: 102.0 mm SL, off Owase, Pacific coast of Mie Prefecture, Japan; NTM S.11116–001, 1: 209.0 mm SL, south Java, Indonesia; NTM S.12001–004, 1: 148.5 mm SL, Roti area, Indonesia; WAM P.19138–001, 1: 163.0 mm SL (holotype of *B. indica*), Timor Sea, off the coast of Western Australia, Australia (17°17'S, 119°57'E); WAM P.19163–001, 1: 173.1 mm SL (paratype of *B. indica*), Timor Sea, off the coast of Western Australia, Australia (13°28'S, 123°09'E).

Other Materials Examined.—USNM uncat., 22, Hawaiian Islands (21°N, 159°W); WAM P29729–016, 3, approx. 60 km west of Dowe Island, Western Australia, Australia (25°02'S, 112°09'E); WAM P29730–007, 3, approx. 60 km west of Dowe Island, Western Australia, Australia (25°02'S, 112°09'E); ZMUC uncat., 1, off Jolo, the Philippines.

Bembrops gobioides (Goode, 1880)

Hypsicometes gobioides Goode, 1880: 348 (off Long Island, New York, USA); Goode and Bean, 1896: 290–291 (description); Jordan and Evermann, 1896–1900: 2294; Alcock, 1902: 120 (listed); Cadenat, 1937: 513–514 (synonymy, listed).

Bembrops gobioides Ginsburg, 1955: 628, 637–639 (key, synonymy, description, figs. 121, 122); Grey, 1959: 336, 339–340 (key, description, color); Miller and Jorgensen, 1973: 309 (meristics); Nelson, 1978: 239 (meristics, short description, distribution); Richards, 1990: 54 (listed).

Diagnosis.—Distinguished from other *Bembrops* by the combination of high number of lateral-line scales (60 or over), short and stumpy maxillary tentacle, dark gray membrane between first and second spines of first dorsal fin, and lateral line descending abruptly beyond origin of pectoral fin. L.L. scales 60–66; D. VI, 16–17; P. 22–26; A. 17–18. A member of the *anatirostris* species group (also including *B. cadenati* and *B. heterurus*) characterized by the extended anterior end of the third hypobranchial. Distinguished from *B. anatirostris* and *B. filifera* in number of second dorsal fin rays (14 or 15 in *B. anatirostris* and 14–16 in *B. filifera*). Distinguished from *B. curvatura* in counts of lateral-line scales (40–49 in *B. curvatura*), second dorsal fin rays (14–15 in *B. curvatura*), and anal fin rays (15–16 in *B. curvatura*).

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 3.

Snout relatively short, 1.0–1.2× eye diameter. Scales present on lateral and dorsal surfaces of snout. Upper jaw extending behind anterior margin of eye. Maxillary tentacle short and stumpy. Lateral line descending relatively abruptly beyond origin of pectoral fin, separated from origin of first dorsal fin by 4–6 rows of scales, from origin of anal fin by 5 or 6, and from insertion of anal fin by 3. No evidence of prolongation of any spine of first dorsal fin. Predorsal length for first dorsal fin almost equal to head length. Caudal fin rounded. Gill rakers 5 or 6 on upper limb and 12–14 on lower limb of branchial arch.

Table 3. Proportional measurements of selected morphometric characters for four species of *Bembrops* (expressed as percentage of standard length)

Measurements	<i>B. filifera</i> (N = 35) (SL = 88.6–219.0 mm)			<i>B. gobioides</i> (N = 22) (S = 43.5–202.0 mm)			<i>B. greyi</i> (N = 3) (SL = 144.6–173.0 mm)			<i>B. heterurus</i> (N = 19) (SL = 82.5–160.0 mm)		
	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD
Head length	35.7–48.6	40.9	2.0	33.8–38.0	35.3	1.3	39.0–41.2	40.1	1.5	36.1–40.6	37.9	1.1
Head width	12.6–16.6	14.4	0.8	11.5–14.6	13.2	0.9	14.2–16.1	15.1	2.0	13.3–17.0	14.6	1.1
Head height	8.5–11.5	9.7	0.7	8.7–10.7	9.6	0.7	10.9	10.9	0	10.1–12.8	11.2	0.8
Snout length	12.8–18.0	14.6	0.8	10.2–12.3	11.3	0.6	11.5–12.3	11.9	1.3	11.2–13.2	12.2	0.6
Postorbital length	16.5–21.2	18.1	0.8	14.2–16.9	15.4	0.7	17.8–18.1	17.9	0.2	16.1–18.2	17.0	0.6
Body depth	9.1–13.8	11.1	1.3	8.7–14.6	11.5	1.3	11.2–12.4	11.8	0.8	11.3–15.9	13.3	1.2
Predorsal length (1st)	37.5–48.5	40.4	1.8	34.0–38.0	35.8	1.3	38.6–40.5	39.5	1.3	37.2–41.0	38.6	1.0
Predorsal length (2nd)	53.0–68.1	56.8	2.7	47.9–52.6	50.4	1.3	53.6–55.0	54.3	1.0	52.3–56.8	54.8	1.1
Postdorsal length (1st)	49.0–57.8	51.6	1.7	52.8–57.7	55.7	1.6	52.3	52.3	0	51.3–55	53.4	1.0
Postdorsal length (2nd)	9.5–13.7	11.1	0.7	11.5–14.0	12.6	0.6	11.5–12.0	11.7	0.4	11.9–14.5	13.1	0.8
Interpectoral distance	9.9–14.1	12.1	1.0	9.4–12.0	11.0	0.7	8.5–11.9	10.2	3.1	10.3–14.9	12.7	1.3
Interpelvic distance	6.1–8.9	7.5	0.7	4.9–6.4	5.7	0.5	4.8–5.6	5.2	0.5	5.3–8.0	7.0	0.6
Length of caudal peduncle	7.4–10.8	8.8	0.8	10.0–11.9	11.1	0.6	5.0–5.2	5.1	0.6	9.9–12.4	11.2	0.7
Depth of caudal peduncle	4.5–5.7	5.0	0.3	3.4–4.9	4.4	0.3	9.5–10.3	9.9	0.1	4.4–5.4	4.8	0.3

Color in Alcohol.—Darker gray dorsally, lighter ventrally. Larger specimens generally darker than smaller ones. Scales with dark posterior edge. A series of 2 or 3 circular dark brown spots along lateral line in some specimens. Membrane between first and second spines of first dorsal fin dark gray; color restricted to upper edge in three specimens. Caudal fin with a prominent, large dark spot (circular, oval or elongated) on its dorsal edge. Peritoneum dark gray to black.

Remarks.—Ginsburg (1955) mentioned a close similarity of this species to *B. anatirostris*, and Grey (1959) compared it with *B. macromma*. The species differs from *B. macromma* in the number of the second dorsal fin rays, the slope of the lateral line, and the presence of scales in the area in front of eye. The results of PCA using *B. anatirostris*, *B. filifera*, and *B. gobioides* specimens (Fig. 3) is discussed in the description of *B. anatirostris*.

Goode (1880) erected the genus *Hypsicometes* for his new species, *H. gobioides*, which he described from one immature specimen (43.5 mm SL) collected from Long Island area, New York. Information on p. 337 of Goode (1880) suggests that he may have had more than one type specimen; however, from p. 347 and information on the USNM specimen (pers. comm., Susan Jewett, 1994) it seems probable that only one specimen was involved. Ginsburg (1955) considered the genus to be a junior synonym of *Bembrops* Steindachner. We have examined the holotype but could not use it in any of the analyses because of its very poor condition. The holotype is from the northernmost locality for the genus and is the only specimen collected so far from the area. Although there is no doubt that the Gulf of Mexico material is distinct at the species level it would be desirable to examine new material from the type locality to strengthen our view that the New York and Gulf of Mexico material is conspecific.

Distribution.—Known from the western Atlantic, primarily from the Gulf of Mexico (Fig. 4).

Biological Notes.—This medium-sized species is known to occur at depths of about 100 m to over 700 m; it is most prevalent in depths greater than 300 m. Staiger (1970), while studying the distribution of fishes in the Straits of Florida, found the species throughout the straits at depths between 315 to 724 m.

Etymology.—The specific name is in reference to the morphological similarity of the species to species of *Gobius*.

Materials Examined.—(22 specimens, 43.5–202.0 mm in SL). USNM 26007, 1: 43.5 mm SL (holotype), off Long Island, New York (40°02'N, 70°23'W); GCRL 15095, 2: 151.4–153.0 mm SL, Gulf of Mexico; UF 12906, 10: 147.8–200.5 mm SL, Atlantic Ocean (29°04'N, 80°00'W); UF 13221, 9: 121.0–195.3 mm SL, Atlantic Ocean (29°04'N, 80°00'W).

Other Materials Examined.—ISH 3591/79, 1, off Florida (29°07'N, 79°59'W); GCRL 15120, 2, Gulf of Mexico (29°10'N, 85°55'W); UF 40089, 10, Gulf of Mexico (27°45'N, 95°07'W); UF 40161, 6, Gulf of Mexico (27°25'N, 95°56'W); USNM 304917, 2, Caribbean Lesser Antilles (15°39'N, 61°10'W); USNM 304920, 2, Gulf of Mexico (28°33'N, 86°09'W).

Bembrops greyi Poll, 1959

Bembrops greyi Poll, 1959: 40 (39 miles north of Port Gentil, Gabon); Knapp, 1981: 2–4, 6 (listed, fig., diagnosis, distribution).

Diagnosis.—Dark brown to black pigmentation entirely or on most of the membrane of first dorsal fin. L.L. scales 48–55; D. VI, 15–17; P. 25; A. 18.

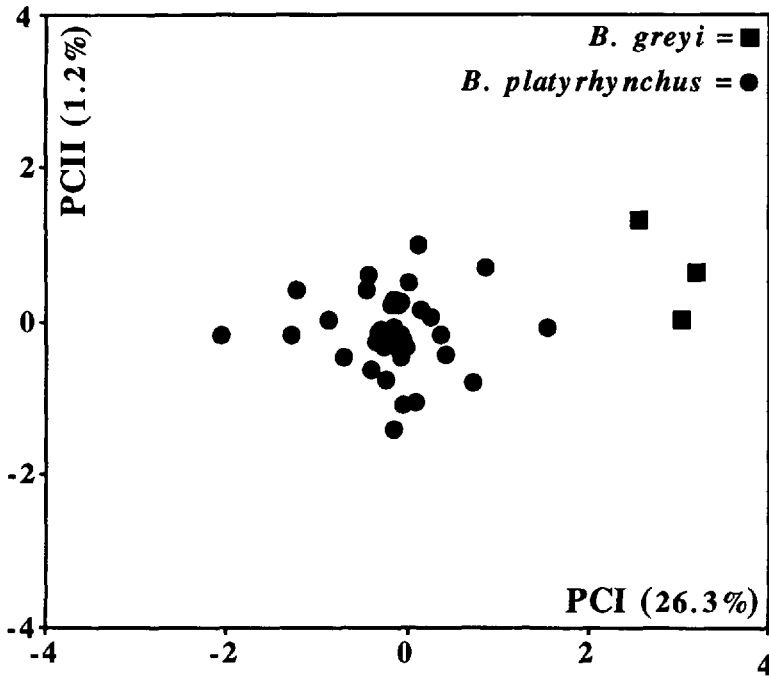


Figure 13. PCA of *B. greyi* and *B. platyrhynchus*. The X axis is the PCI of data set 3 and the Y axis is the PCII of data set 2. Percent variance of total variation for each factor is given in parentheses.

Descriptions.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 3.

Snout short, 1.1–1.2× eye diameter. Scales on lateral and dorsal sides of snout. Upper jaw extending behind anterior margin of eye reaching almost to its midline. Lateral line descending adjacent to pectoral fin with 48–55 scales (the three specimens examined have 52 and 55 scales), separated from origin of first dorsal fin by 2 or 3 rows of scales, from origin of anal fin by 5, and from insertion of anal fin by 3. Dorsal fin VI, 15–17 (our three specimens have 16 and 17 rays). None of the spines of first dorsal fin prolonged. Predorsal length for first dorsal fin slightly less than head length. Pectoral fin moderately rounded at its outer margin with 24–27 (our three specimens have 24 or 25) branched rays. Gill rakers, 5 on upper limb of branchial arch and 11 or 12 on lower limb in three specimens.

Color in Alcohol.—Light yellow dorsally, even lighter ventrally. Posterior edge of scales above lateral line dark brown to black. Membranes between all six spines of first dorsal fin entirely or in most part dark brown to black. Membranes between soft rays of second dorsal fin with scattered black spots. Base of pectoral fin dark brown. Prominent dark spot on dorsal edge of caudal fin. Peritoneum almost black.

Remarks.—*Bembrops greyi* can be distinguished from all other species by its dark first dorsal fin. PCA scatter plots show that this species and the otherwise very similar *B. platyrhynchus* can further be separated on PCI of the data set 3 with the heaviest loadings on the number of the second dorsal and the anal fin rays (Fig. 13).

Distribution.—Eastern Atlantic off coasts of Guinea, Gabon, Congo, and Angola (Fig. 9).

Biological Notes.—This is a medium-sized species of *Bembrops* known to occur on soft bottoms of the continental shelf at depths between 250 and 420 m. One female collected in March had mature ova. Individuals are reported to feed on other fish (Knapp, 1981).

Etymology.—The species was named for Marion Grey (Poll, 1959).

Materials Examined.—(3 specimens, 144.6–173.0 mm in SL). ISNB 364, 1: 144.6 mm SL (paratype), Angola (10°05'S, 17°0'W); ISNB 13.695, 1: 163.5 mm SL, approx. 45 miles from Port Gentil, Gabon (00°40'S, 08°58'E); ISH 1223/64, 1: 173.0 mm SL, off coast of Guinea (09°58'N, 16°50'W).

Other Materials Examined.—ZMUC uncat., 7, off French equatorial Africa (02°09'N, 09°27'E).

Bembrops heterurus (Ribeiro, 1903)

Hypsicometes heterurus Ribeiro, 1903: 186 (Ilha Rasa, off coast 50–100 m, Brazil); Ribeiro, 1915: 4 (coast off Rio de Janeiro, Brazil); Cadenat, 1937: 513–514 (synonymy, listed).

Bembrops heterurus Poll, 1959: 35–40, 378 (description, distribution, fig. 12); Nelson, 1978: 240 (meristics, distribution); Knapp, 1981: 2, 4–6 (listed, fig., diagnosis, distribution).

Diagnosis.—Upper lobe of caudal fin elongated at an acute angle. L.L. scales 54–60; D. VI, 14–15; P. 17–24; A. 16–18. A member of the *anatirostris* species group (also including *cadenati* and *gobioides*), defined by the extended anterior end of the third hypobranchial. Distinguished from *B. cadenati* and *B. macromma* in number of anal fin rays (17 in 84% of specimens vs. 18 in *B. cadenati* and 77% of *B. macromma* specimens).

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 3.

Snout relatively short, 1.0–1.4× eye diameter. Scales on lateral and dorsal surfaces of snout including area in front of eye. Upper jaw extending behind anterior margin of eye but not reaching its mid-line. Maxillary tentacle short. Lateral line descending gradually along dorsal edge of pectoral fin, separated from origin of first dorsal fin by 4 or 5 rows of scales, from origin of anal fin by 6 or 7, and from insertion of anal fin by 3–5. Pectoral fin moderately rounded. Rays of upper lobe of caudal fin relatively elongated in undamaged specimens forming a somewhat acute angle with lower lobe; lower lobe truncate or rounded. Gill rakers 4–6 on upper limb and 12–15 on lower limb of branchial arch.

Color in Alcohol.—Light yellowish to yellowish brown dorsally, light yellowish brown to creamy brown ventrally. A series of six to eight oval-shaped dusky spots along lateral line. Membrane between first and second spines of first dorsal fin dark gray. Peritoneum dark gray to black.

Remarks.—*B. heterurus* was compared with *B. cadenati*, *B. macromma*, and *B. morelandi* using two combinations of species. One combination includes specimens of *B. cadenati*, *B. macromma*, and *B. heterurus* (see *B. cadenati* account for more details on this combination), whereas the other includes *B. morelandi* instead of *B. cadenati*. In scatter plots (Fig. 14) of the second combination of species, the single specimen of *B. morelandi* shows closer similarity with the specimens of *B. heterurus*. *B. heterurus* is separated on the PCII axis from the other three species by a contrast among the number of scale-rows between the lateral line and the origin of the first dorsal fin. The number of scales between the first dorsal fin spine and the lateral line, and the anal fin ray number have the highest loadings among the characters of the data set 3.

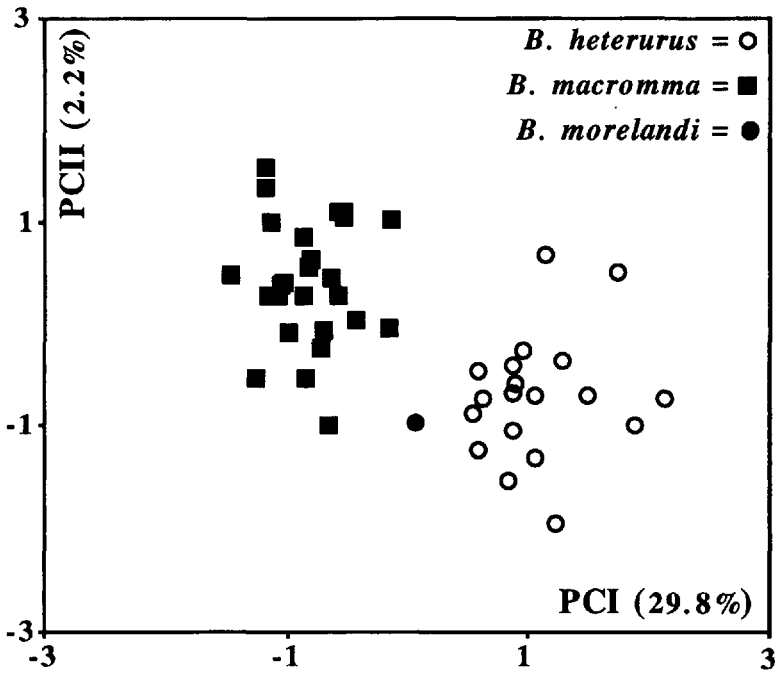


Figure 14. PCA of *B. heterurus*, *B. macromma*, and *B. morelandi*. The X axis is the PCI of data set 3 and the Y axis is the PCII of data set 2. Percent variance of total variation for each factor is given in parentheses.

We were unable to locate the type specimen of *B. heterurus* owing to lack of information in the original description. However, most of the specimens used in this study came from the vicinity of the type locality.

Poll (1959) identified a number of specimens from the Gulf of Guinea off the coast of Africa as *B. heterurus* and considered the species to be a senior synonym of *B. caudimaculata* (= *cadenati*). The examination of the holotype of *B. cadenati* suggests that the two species are not conspecific.

Distribution.—Atlantic, off the coast of Brazil in the western Atlantic and the Gulf of Guinea in the eastern Atlantic (Fig. 4).

Biological Notes.—This medium-sized species occurs at depths between 100 and 390 m (Poll, 1959). All the specimens examined came from relatively shallow water at depths between about 90 to 200 m. Females with mature ova were collected in August from the Gulf of Guinea (Poll, 1959). Principle prey items are crustaceans and other fishes (Poll, 1959; Knapp, 1981).

Etymology.—Not specified in the original description, but the specific name is probably from the Greek *heteros*, meaning different, and *oura* meaning tail.

Materials Examined.—(19 specimens, 82.5–160.0 mm in SL). FURG uncat., 4: 117.5–160.0 mm SL, Rio Grande do Sul, Brazil; FURG uncat., 5: 114.7–128.1 mm SL, Rio Grande do Sul, Brazil; FURG uncat, 5: 90.0–115.1 mm SL, Rio Grande do Sul, Brazil; MZUSP 38917, 2: 82.5–120.5 mm SL, off Brazil (23°15'S, 42°24'W); MZUSP 38918, 2: 130.7–135.2 mm SL, off Brazil (30°28'S, 48°42'W); UAMZ 4647, 1: 122.3 mm SL, Rio Grande do Sul, Brazil (32°41'S, 50°35'W).

Other Materials Examined.—IRSNB 13.679, 3, off Liberia (05°52'S, 11°43'E); IRSNB 13.687, 10, off Gabon (00°45'S, 08°58'E); ISH 1144/64, 1, off coast of Liberia (06°32'N, 11°29'W); ISH 1271/64, 2, off coast of Ivory Coast (05°12'N, 04°09'W); MZUSP 38919, 4 (30°40'S, 49°09'W); UF 47051,

1, off Gabon (00°02'S, 08°02'E); USNM 304919, 26, Guinea (09°43'N, 16°08'W); ZMUC uncat., 23, off French equatorial Africa (02°09'N, 09°27'E); ZMUC uncat., 11, off French equatorial Africa (02°09'N, 09°27'E).

Bembrops macromma Ginsburg, 1955

Bembrops macromma Ginsburg, 1955: 634 (off Virgin Islands); Grey, 1959: 336, 340–342 (key, description, color, fig. 55); Miller and Jorgensen, 1973: 309 (meristics); Nelson, 1978: 240 (meristics, distribution); Uyeno et al., 1983: 40 (listed); Richards, 1990: 54 (listed).

Diagnosis.—Caudal fin truncated with dark gray pigmentation along entire posterior edge and scales absent in small area in front of eye. L.L. scales 54–64; D. VI, 14–15; P. 22–24; A. 17–18. Further distinguished from *B. cadenati* by its larger eye and from *B. heterurus* by the relatively more gradual slope of lateral line, and hence the lower number of scale-rows between lateral line and origin of first dorsal fin ($\bar{x} = 3.3$ in *macromma* vs. $\bar{x} = 4.9$ in *heterurus*). Differentiated from *B. morelandi* in having relatively light peritoneum.

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 4.

Snout relatively short, 0.8–1.4× eye diameter. Scales on lateral and dorsal sides of snout in most specimens (92% of the specimens examined); a small area in front of eye without scales in most specimens. Upper jaw extending behind anterior margin of eye reaching almost to its mid-line. Maxillary tentacle short and stubby. Lateral line descending gradually, reaching mid-line at tip of pectoral fin, separated from origin of first dorsal fin by 3–5 rows of scales, from origin of anal fin by 5–7, and from insertion of anal fin by 2 or 3. Second spine of first dorsal fin prolonged in some specimens. Pectoral fin pointed in most specimens. Gill rakers 4–6 on upper limb of branchial arch and 12–15 on lower limb.

Color in Alcohol.—Light to dark yellowish brown dorsally, relatively light ventrally. A series of three to nine large and small dusky spots along lateral line. Membranes between first, second, and third spines of first dorsal fin dark gray to black for entire height. Ginsburg (1955) observed “a small black spot at base of [first dorsal] fin behind third spine” in one specimen. Entire posterior edge of caudal fin dark gray to black in most specimens, lighter in others. Peritoneum dark gray to black.

Remarks.—*Bembrops macromma* is morphologically similar to *B. cadenati* and *B. heterurus*. Results of the PCA (Fig. 6) show that *B. macromma* can be separated from the holotype of *B. cadenati* and from *B. heterurus* on the PCI of the data set 3. See *B. cadenati* account for more comparative information.

Distribution.—Known from the Gulf of Mexico and the Caribbean Sea (Fig. 12).

Biological Notes.—This medium-sized species occurs at depths of about 150 to 550 m; most specimens are from depths below 250 m. Female specimens with a mature gonad were collected in May.

Etymology.—The specific name is derived from the Greek *makros*, meaning large, and *omos*, meaning shoulder.

Materials Examined.—(35 specimens, 78.8–232.2 mm in SL). USNM 108392, 1: 153.7 mm SL (holotype), West Indies, Virgin Islands (18°35'30"N, 65°23'54"W); UF 15615, 2: 125.4–130.3 mm SL, southwest Caribbean off Nicaragua (16°08'N, 81°13'W); UF 47052, 2: 102.1–113.2 mm SL, Caribbean Sea south of Jamaica (17°50'N, 77°52'W); USNM 304921, 2: 120.4–232.2 mm SL, Caribbean Sea off Colombia (11°09'N, 74°24'W); USNM 304922, 6: 100.7–153.6 mm SL, Puerto Rico (18°26'N, 67°11'W); USNM 304923, 8: 78.8–101.7 mm SL, Caribbean Sea off Jamaica (17°50'N, 77°52'W); USNM 304925, 3: 98.8–144.2 mm SL, Great Bahama Bank area off Cuba (23°04'N, 78°46'W); USNM

304926, 4: 84.5–111.7 mm SL, Leeward Islands (17°38'N, 62°16'W); USNM 304927, 3: 125.0135.1 mm SL, Caribbean Sea near Antigua Island (17°27'N, 62°04'W); USNM 304928, 2: 94.1–102.5 mm SL, Off Jamaica (17°50'N, 77°52'W); USNM 304929, 2: 115.0–157.2 mm SL, Nicaragua (14°17'N, 81°55'W).

Bembrops magnisquamis Ginsburg, 1955

Bembrops magnisquamis Ginsburg, 1955: 633 (off Santiago, Cuba); Nelson, 1978: 240 (meristics, distribution); Richards, 1990: 54 (listed).

Diagnosis.—Lateral line with gradual slope. L.L. scales 45–50; D. VI, 15–16; P. 21–22; A. 17. Distinguished further from *B. caudimacula* and *B. nematopterus* by higher number of fin rays in second dorsal fin, lower number of scale-rows between lateral line and insertion of anal fin, and presence of dark brown pigmentation at base of membranes between anterior four spines of first dorsal fin.

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 4.

Snout relatively short, almost equal to eye diameter, with scales on lateral and dorsal surfaces including the area in front of eye. Upper jaw extending behind anterior margin of eye. Maxillary tentacle long, tapering at the end. Lateral line descending gradually in region of pectoral fin, separated from origin of first dorsal fin by 2–4 rows of scales, from origin of anal fin by 4–5, and from insertion of anal fin by 2. Spines of first dorsal fin not elongated. Caudal fin rounded. Gill rakers 4–5 on upper limb and 12–14 on lower limb of first branchial arch.

Color in Alcohol.—Uniformly light yellowish brown. Membranes between first four spines of first dorsal fin dark brown at their base. Anal fin with faint brown margin. Caudal fin with light-brown transverse patch along dorsal edge in some specimens. Peritoneum light brown with occasional dark brown spots.

Remarks.—Despite the strong morphological similarity of *B. magnisquamis* with *B. caudimacula* and *B. nematopterus*, principal components analyses showed that it can be distinguished from the other two based on the differences in the length of the second dorsal fin, the number of fin rays in the second dorsal fin and the anal fin, and the number of scales between the last anal fin ray and the lateral line (Figs. 7, 10). The morphometric analyses are discussed in detail in the description of *B. caudimacula*.

Distribution.—Known from the Caribbean Sea (Fig. 9).

Biological Notes.—This small to medium-sized species occurs in relatively deep water, at depths between 350 and 465 m. Females collected in May had ripe ova.

Etymology.—The specific name is derived from the Latin *magnus*, meaning large, and *squama*, meaning scale.

Materials Examined.—(5 specimens, 84.3–105.2 mm in SL). USNM 045985, 1: 84.3 mm SL (holotype), Caribbean Sea off Santiago, Cuba (19°56'N, 75°47'W); USNM 304924, 4: 86.8–105.2 mm SL, Caribbean Sea off Costa Rica (12°31'N, 82°21'W).

Bembrops morelandi Nelson, 1978

Bembrops morelandi Nelson, 1978: 238 (northwestern part of Bay of Plenty, New Zealand); Paulin et al., 1989: 217 (key, fig. 150.2), diagnosis, distribution).

Diagnosis.—Distinguished from the other species of *Bembrops* by the following combination of characters: 56–58 lateral-line scales, about four large spots along

lateral line, and jet-black peritoneum. L.L. scales 56–58; D. VI, 13–14; P. 25–26; A. 16–17.

Description.—Nine meristic characters for the holotype and the paratype, and proportions for 14 morphometric characters for the paratype given in Tables 1 and 4.

Snout relatively long, $1.8\times$ eye diameter. Scales present on lateral and dorsal sides of snout. Upper jaw extending to midway between anterior margin and middle of eye. Maxillary tentacle long and slender. Lateral line descending gradually in region of pectoral fin, separated from origin of first dorsal fin by 3 rows of scales, from origin of anal fin by 6, and from insertion of anal fin by 3. Nelson (1978) stated that the first spine of first dorsal fin shows some evidence of prolongation in larger specimen (not shown by the paratype). Pectoral fin rounded. Caudal fin rounded. Gill rakers 4 on upper limb and 15 on lower limb of branchial arch.

Color in Alcohol.—Yellowish gray dorsally, slightly lighter ventrally. Scales with indistinct brown posterior edge. A series of four large dusky spots along lateral line. Entire membrane between first and second spines of first dorsal fin jet black; pigmentation extends along lower half of membranes between second and fourth spines. Black band along entire distal and proximal edge of second dorsal fin. Caudal fin with two dark spots on its dorsal edge and a dark hollow circular spot in the middle (observed in the paratype). Peritoneum with jet-black pigmentation.

Remarks.—*Bembrops morelandi* was compared with *B. heterurus* and *B. macromma* because of their morphological similarity. See account of *B. heterurus* for a discussion of the morphometric analysis.

Distribution.—This species is known only from the holotype and paratype, collected from the northwestern part of the Bay of Plenty, New Zealand (Fig. 9).

Biological Notes.—Both the holotype and paratype were collected by trawling at depths between 366 and 395 m. Both specimens are adult males; the testes in the holotype are larger than those in the paratype (Nelson, 1978).

Etymology.—*B. morelandi* was named for Dr. J. M. Moreland of National Museum of New Zealand, in recognition of his contribution to the study of fishes of New Zealand (Nelson, 1978).

Materials Examined.—(1 specimen, 207.0 mm in SL). NMNZ P.7581, 1 (paratype), northwestern part of the Bay of Plenty, New Zealand (36°30'S, 176°10'E).

Bembrops nematopterus Norman, 1939

Bembrops nematopterus Norman, 1939: 70 (Zanzibar).

Diagnosis.—Gradually descending lateral line (lowest of any *Bembrops*), 2 lateral-line scales between lateral line and origin of first dorsal fin (the fewest of any species), and blackish pigmentation on membrane between anterior two spines of first dorsal fin. L.L. scales 44–48; D. VI, 13–14; P. 21–22; A. 16.

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 4.

Snout moderately long, $1.2\text{--}1.6\times$ eye diameter. Scales present on lateral and dorsal sides of snout including the area in front of eye. Upper jaw extending behind anterior margin of eye, almost to the mid-line. Maxillary tentacle long. Lateral line rising sharply above pectoral fin at base for 2–2.5 scale rows and

Table 4. Proportional measurements of selected morphometric characters for five species of *Bembrops* (expressed as percentage of standard length)

Measurements	<i>B. macromma</i> (N = 35) (SL = 78.8–232.2 mm)			<i>B. magnisquamis</i> (N = 5) (S = 84.3–105.2 mm)			<i>B. morelandi</i> (N = 1) (SL = 164.3 mm)	<i>B. nematopterus</i> (N = 3) (SL = 109.7–142.9 mm)			<i>B. platyrhynchus</i> (N = 43) (SL = 51.6–214.0 mm)		
	Range	Mean	SD	Range	Mean	SD	Paratype	Range	Mean	SD	Range	Mean	SD
Head length	36.7–43.3	39.1	1.7	35.7–39.9	37.5	1.9	41.9	38.1–42.3	40.1	3.2	38.2–46.9	40.1	1.6
Head width	13.4–17.7	15.6	1.1	13.5–15.2	14.4	0.7	15.2	15.9–16.2	16.1	0.2	13.6–18.1	15.4	1.0
Head height	9.7–13.1	11.6	0.8	9.2–9.9	9.7	0.3	9.6	11.6–12.2	11.8	0.3	9.1–13.3	11.1	0.9
Snout length	10.8–14.9	12.0	1.0	10.0–11.9	11.1	0.8	14.6	12.9–13.4	13.2	0.2	11.3–16.0	13.0	0.8
Postorbital length	16.4–19.4	17.5	0.8	15.1–19.5	17.0	1.7	19.0	16.1–17.4	16.9	0.7	16.1–23.7	17.8	1.0
Body depth	10.4–13.9	12.0	1.1	8.6–10.6	9.6	0.7	10.1	12.3–13.3	12.8	0.5	10.1–16.0	12.8	1.3
Predorsal length (1st)	36.2–43.4	38.5	1.7	36.4–37.9	37.3	0.7	41.1	38.6–40.9	39.5	1.2	38.0–44.0	40.8	1.6
Predorsal length (2nd)	53.9–59.4	55.6	1.3	42.3–54.5	53.6	0.8	57.4	54.2–56.3	55.5	1.5	53.9–60.2	56.8	1.6
Postdorsal length (1st)	47.5–55.2	52.4	1.8	54.0–56.5	55.1	0.9	51.5	50.8–52.9	51.9	1.0	47.8–56.4	50.8	2.0
Postdorsal length (2nd)	11.2–14.9	13.5	0.9	12.0–13.9	12.8	0.8	14.4	11.4–13.8	12.3	1.3	9.6–14.4	12.6	0.9
Interpectoral distance	10.2–15.2	12.3	1.1	9.5–13.4	11.7	1.4	12.3	11.7–13.1	12.5	0.8	8.7–15.4	12.0	1.5
Interpelvic distance	4.6–7.7	6.4	1.1	5.8–7.7	6.8	0.8	8.0	7.2–10.5	9.1	1.6	5.2–8.5	6.4	0.9
Length of caudal peduncle	7.6–11.8	10.1	1.1	8.8–10.7	9.8	0.8	10.8	9.6–10.7	9.8	0.8	9.7–13.2	10.8	0.8
Depth of caudal peduncle	4.6–5.8	5.2	0.3	5.0–6.1	5.5	0.5	5.2	5.5–5.8	5.7	0.2	5.2–6.9	6.1	0.5

then descending gradually along length of pectoral fin, separated from origin of first dorsal fin by 2 rows of scales, from origin of anal fin by 5, and from insertion of anal fin by 3. First spine of the first dorsal fin prolonged, even in a relatively small specimen. Predorsal length (to first dorsal fin) almost equal to head length. Pectoral fin rounded. Caudal fin rounded. Gill rakers 5 on upper limb of branchial arch and 15 or 16 on lower limb.

Color in Alcohol.—Yellowish brown dorsally and dorsolaterally, lighter below. Scales, especially on and close to dorsal side, with dark-brown edge. A series of 2–4 oval, brown, indistinct blotches along lateral line. Norman (1939) also noted some yellowish-green markings on head. Membrane between first two spines of first dorsal fin almost black distally. Membranes between rays of second dorsal fin with few brown spots. A thick, dark-brown line along ventral edge of caudal fin, and an indistinct brown blotch on dorsal edge. Peritoneum light brown with scattered dark spots.

Remarks.—*Bembrops nematopterus* is morphologically similar to *B. caudimacula* and *B. magnisquamis*, and Smith (1965) synonymized this species with *B. caudimacula*. Klausewitz (1980) suggested *B. nematopterus* to be a sexual dimorphism of *B. adenensis*. The morphometric analyses, however, revealed *B. nematopterus* to be distinct from that species and it is regarded as a valid species (Figs. 7, 11). Prolongation of the first spine of the first dorsal fin, distance between insertion of second dorsal fin and insertion of anal fin, and number of scale-rows between the lateral line and origin of first dorsal fin are some of the characters by which this species can be distinguished from the other two species. A discussion of the principal components analyses is given in the description of *B. caudimacula*.

Distribution.—Known from the western Indian Ocean off the coast of Zanzibar, Africa (Fig. 9).

Biological Notes.—This species, the smallest of any *Bembrops*, occurs at depths of 183 to 293 m (Norman, 1939).

Etymology.—The specific name is derived from the Greek *nematos*, meaning thread, and *pteros*, meaning wing or fin, and refers to the thread-like elongation of the first spine of the first dorsal fin.

Materials Examined.—(3 specimens, 109.7–142.9 mm in SL). BMNH 1939.5.24: 1272–7, 2: 137.0 mm SL (holotype), 142.9 mm SL (paratype), off Zanzibar; BMNH 1939.5.24: 1278–80, 1: 109.7 mm SL, off Zanzibar.

Bembrops platyrhynchus (Alcock, 1894a)

Bathypercis platyrhynchus Alcock, 1894a: 178 (Bay of Bengal, India).

Bembrops platyrhynchus Alcock, 1894b: 118; Cadenat, 1937: 513 (synonymy); Norman, 1939: 68–69 (synonymy, distribution, description); Nelson, 1978: 239 (meristics, short description, distribution); Heemstra and Nelson, 1984: 2 (listed, distribution); Heemstra and Nelson, 1986: 738 (synonymy, meristics, diagnosis, figs.).

Bembrops filifer Fowler, 1938a: 92 (Anima Sola Island, N., between Burias and Luzon, the Philippines).

Bembrops philippinus Fowler, 1939: 2 (replacement for *B. filifer* Fowler, 1938a, preoccupied by *B. filifera* Gilbert); Nelson, 1978: 240 (meristics, distribution); Fourmanoir, 1985: 38 (synonymy, listed).

Bembrops filamentosa Norman, 1939: 70 (replacement for *B. filifer* Fowler, 1938a, preoccupied by *B. filifera* Gilbert).

Bembrops aethalea McKay, 1971: 42 (Indian Ocean, off northern coast of Western Australia, Australia); Nelson, 1978: 240 (meristics, distribution).

Diagnosis.—Gradually descending lateral line, 47–57 lateral-line scales, and dark gray to black pigmentation on distal edge of membranes between all spines of first dorsal fin. D. VI, 13–16; P. 22–25; A. 15–17. Distinguished from *B. caudimacula* in having fewer scales between lateral line and origin of anal fin (4–6 in *B. platyrhynchus* vs. 5–7 in *B. caudimacula*). Further distinguished from *B. greyi* in having dark pigmentation only along distal edge of first dorsal fin.

Description.—Frequency distributions for nine meristic characters and proportions for 14 morphometric characters given in Tables 1 and 4.

Snout moderately long, 1.0–1.7× eye diameter, with scales present on lateral and dorsal sides. Upper jaw extending behind anterior margin of eye. Maxillary tentacle long and slender, somewhat pointed at its tip. Lateral line descending gradually along dorsal edge of pectoral fin, separated from origin of first dorsal fin by 2–4 rows of scales, from origin of anal fin by 4–6, and from insertion of anal fin by 3 or 4. First spine of first dorsal fin elongated in some adult specimens. Predorsal length for first dorsal fin almost equal to head length. Pectoral fin moderately pointed at its posterior edge. Caudal fin rounded. Gill rakers 3–5 on upper limb and 11–15 on lower limb of branchial arch.

Color in Alcohol.—Yellowish brown dorsally, lighter ventrally with 8–13 large dark-brown spots along lateral line. Distal edge of membranes between all spines of first dorsal fin blackish dark gray to black. Dorsal and ventral edge of caudal fin with dark blotch; a dark caudal spot sometime present at upper base. Peritoneum dark grayish to pale black.

Remarks.—When Alcock (1894a) erected a new genus and species, *Bathypercis platyrhynchus*, for a 109 mm long specimen collected by the Indian Marine Survey Steamer INVESTIGATOR from the Bay of Bengal, he was unaware of the genus *Bembrops* Steindachner. In a subsequent publication (Alcock, 1894b) he considered *Bathypercis* as a junior synonym.

Some workers (Alcock, 1899, 1902; Kuroda, 1950; Smith, 1965) regarded *Bembrops platyrhynchus* as a junior synonym of *B. caudimacula* because of their morphological similarity. Although our morphometric analyses (Fig. 8) confirms a close resemblance between the two species, we recognize *B. platyrhynchus* as a valid species because of differences in coloration in the spinous dorsal fin (dark pigmentation present distally on the membranes between all six spines of the first dorsal fin in *B. platyrhynchus*) and in some osteological characters (Das, 1993). Scatter plots also separate *B. platyrhynchus* and *B. greyi* using two data sets (Fig. 13).

However, we consider two other nominal species, *B. philippinus* Fowler (= *B. filifer* Fowler, *B. filamentosa* Norman) and *B. aethalea* McKay to be junior synonyms of *B. platyrhynchus*. Fowler (1938a) described *B. filifer* from specimens collected in the Philippines. Later, because of the similarity of the specific name with that of *B. filifera*, Fowler (1939) renamed his species *B. philippinus*. Norman (1939) proposed *B. filamentosa* for *B. filifer*, citing preoccupation of the name. Fowler (1938a) also noted that *B. philippinus* differs from Alcock's figure of *B. platyrhynchus* in having a "larger eye, a more posterior insertion of the first dorsal fin, and a notched edge of anal fin." However, the holotype and several paratypes of *B. philippinus* show no distinct difference from *B. platyrhynchus*. *Bembrops aethalea* was described by McKay (1971) from samples taken off the northern coast of Western Australia. An examination of the holotype and four paratypes failed to find any difference with *B. platyrhynchus* and we regard the two as conspecific.

Distribution.—Known from the Indo-West Pacific, including the Bay of Bengal, the South China Sea, the Philippine Sea, the Tasman Sea, and off the coast of Somalia and South Africa (Fig. 12).

Biological Notes.—This medium-sized species occurs at depths of about 100 to 350 m. One female specimen with mature ova was collected in the Philippine Sea in March.

Etymology.—The specific name is derived from the Greek *platys*, meaning flat, and *rhynchos*, meaning snout or beak.

Materials Examined.—(43 specimens, 51.6–214.0 mm in SL). ZSI 13437, 1: 88.5 mm SL (holotype), Bay of Bengal, India; WAM P.19144–001, 1: 178.8 mm SL (holotype of *B. aethalea*), Indian Ocean off northern coast of Western Australia, Australia (13°45'S, 123°30'E); WAM P.19148–19151, 4: 121.4–182.1 mm SL (paratypes of *B. aethalea*), Indian Ocean off northern coast of Western Australia, Australia (13°47'S, 123°18'E); USNM 98866, 1: 214.0 mm SL (holotype of *Bembrops philippinus*), Anima Sola Island, N., between Burias and Luzon, the Philippines (12°52'N, 123°23'E); USNM 98940, 2: 141.4–194.6 mm SL (paratypes of *B. philippinus*), north of Tawi Tawi, the Philippines (05°28'N, 120°02'E); USNM 98944, 4: 109.3–196.2 mm SL (paratypes of *B. philippinus*), between Cebu and Bohol, the Philippines (10°08'N, 123°50'E); USNM 98948, 1: 178.6 mm SL (paratype of *B. philippinus*), west coast of Luzon, the Philippines (16°33'N, 119°52'E); USNM 98952, 2: 198.1–198.7 mm SL (paratypes of *B. philippinus*), Camp Overton Lt., Iligan Bay; USNM 98953, 1: 143.3 mm SL (paratype of *B. philippinus*), between Leyte and Cebu, the Philippines (11°11'N, 124°15'E); USNM 98957, 8: 51.6–173.9 mm SL (paratypes of *B. philippinus*), Murcielagos Bay, the Philippines (08°46'N, 123°32'E); USNM 98960, 6: 112.1–137.7 mm SL (paratypes of *B. philippinus*), between Leyte and Cebu, the Philippines (11°10'N, 124°17'E); USNM 98974, 4: 62.8–124.6 mm SL (paratypes of *B. philippinus*), Pt. Togolo Lt. (08°47'N, 123°31'E); USNM 98976, 1: 82.0 mm SL (paratype of *B. philippinus*), Gulf of Boni, Celebes Island, Dutch East Indies (03°34'N, 120°50'E); AMS I.20118–019, 5: 143.6–161.5 mm SL, east of Wooli, N.S.W., Australia; NTM S.10998–002, 1: 90.1 mm SL, Indonesia; USNM uncat., 1: 103.8 mm SL, Gulf of Aden near Gubbat Kalwein, Somalia (11°10'N, 47°55'E).

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Appendix 1. Morphometric, truss, and meristic characters and attributes used in the taxonomic descriptions and analyses

Morphometric characters

1. Total length (TL).
2. Standard length (SL).
3. Head length (HDL).
4. Head width (HDW).
5. Head height (HDH).
6. Length of orbit (EYD).
7. Snout length (SNL).
8. Postorbital length (POL).
9. Length of maxillary tentacle (TNTL).
10. Length of upper jaw (UPJL).
11. Body depth (BDD).
12. Predorsal length (1st) (PRDR1).
13. Predorsal length (2nd) (PRDR2).
14. Postdorsal length (1st) (PSDR1).
15. Postdorsal length (2nd) (PSDR2).
16. Length of pectoral fin (PECFL).
17. Interpectoral distance (INPECD).
18. Length of pelvic fin (PELFL).
19. Interpelvic distance (INPELD).
20. Interorbital width (IOW).
21. Length of caudal peduncle (LCPD).
22. Depth of caudal peduncle (HCPD).
23. Length of 1st dorsal fin base (DRFNB1).
24. Length of 2nd dorsal fin base (DRFNB2).
25. Length of anal fin base (ANLFNB).
26. Anus to origin of anal fin (ANSANL).

Truss characters (=Interlandmark distances) (see Fig. 1)

1. TRUSS 1: Tip of snout to occiput (1-2).
2. TRUSS 2: Tip of snout to origin of 1st dorsal fin (1-3).
3. TRUSS 3: Occiput to origin of 1st dorsal fin (2-3).
4. TRUSS 4: Origin of 1st dorsal fin to origin of 2nd dorsal fin (3-4).
5. TRUSS 5: Origin of 2nd dorsal fin to insertion of 2nd dorsal fin (4-5).
6. TRUSS 6: Insertion of 2nd dorsal fin to dorsal tip of hypural plate (5-6).
7. TRUSS 7: Dorsal tip of hypural plate to ventral tip of hypural plate (6-7).
8. TRUSS 8: Ventral tip of hypural plate to insertion of anal fin (7-8).
9. TRUSS 9: Insertion of anal fin to origin of anal fin (8-9).
10. TRUSS 10: Origin of anal fin to insertion of pelvic fin (9-10).

11. TRUSS 11: Tip of snout to insertion of pelvic fin (1-10).
12. TRUSS 12: Occiput to insertion of pelvic fin (2-10).
13. TRUSS 13: Origin of 1st dorsal fin to insertion of pelvic fin (3-10).
14. TRUSS 14: Origin of 2nd dorsal fin to insertion of pelvic fin (4-10).
15. TRUSS 15: Origin of 1st dorsal fin to origin of anal fin (3-9).
16. TRUSS 16: Origin of 2nd dorsal fin to origin of anal fin (4-9).
17. TRUSS 17: Insertion of 2nd dorsal fin to origin of anal fin (5-9).
18. TRUSS 18: Origin of 2nd dorsal fin to insertion of anal fin (4-8).
19. TRUSS 19: Insertion of 2nd dorsal fin to insertion of anal fin (5-8).
20. TRUSS 20: Dorsal tip of hypural plate to insertion of anal fin (6-8).
21. TRUSS 21: Insertion of 2nd dorsal fin to ventral tip of hypural plate (5-7).

Meristic characters

1. Lateral-line scales (LATL).
2. Scales above lateral line (LATR).
3. 1st dorsal fin spines (DRF1S).
4. 2nd dorsal fin rays (DRF2R).
5. Pectoral fin rays (PECFR).
6. Pelvic fin spine (PELFS).
7. Pelvic fin rays (PELFR).
8. Anal fin rays (ANLFR).
9. Caudal fin rays (CAUDFR).
10. Gill rakers on upper limb (GLRUL).
11. Gill rakers on lower limb (GLRL).
12. Branchiostegal rays (BRACSTGL).
13. Rows of scales between lateral line and origin of 1st dorsal fin (DRSLTSF).
14. Rows of scales between lateral line and origin of anal fin (ANLLTSF).
15. Rows of scales between lateral line and insertion of anal fin (ANLLTSL).

Attributes

1. Slope of lateral line (LATLSLP).
2. Color of peritoneum (PRTNM).